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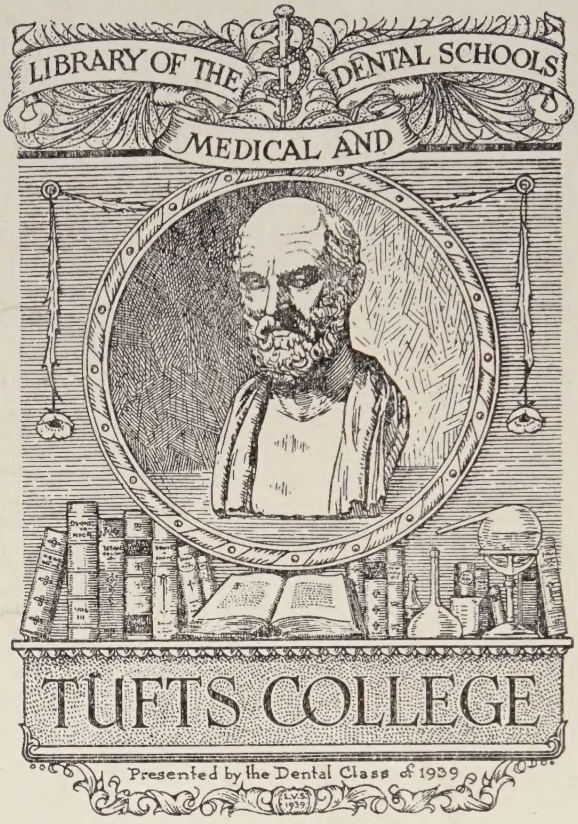

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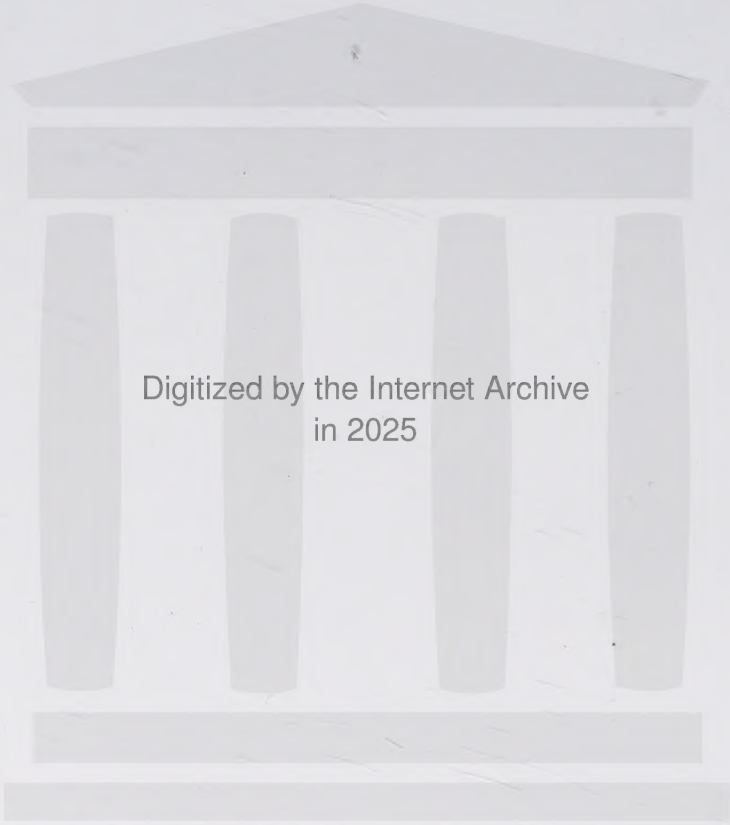
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PRACTICAL
DENTAL PORCELAINS

BY

J. F. HOVESTAD, D.M.D.

Formerly Head of the Crown and Bridge Department, Harvard University Dental School; Founder of the Harvard Crown and Bridge Club; Chairman of the Boston Study and Clinic Club, Boston, Mass.; Author of "Principles and Practice of Crown and Bridge Work."

WITH ONE HUNDRED AND TWENTY-ONE ILLUSTRATIONS

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1924

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PREFACE

While certain limited dental restorations in glass and precious stones come to us from prehistoric periods, the art of usefully replacing lost tooth substance with low and high fusing porcelain is of comparatively recent origin. Primitive attempts were for purposes of ornament only, as museum collections demonstrate: modern art is constructively aesthetic. Herbst, Jenkins and Land were probably pioneers in the field of modern dental porcelain, the latter giving to the profession the platinum matrix, and with it the gateway to the employment of high-fusing bodies. During a period of thirty years the use of dental porcelain has passed through the usual era of successive enthusiastic abuse, with resulting disappointment, followed by a gradual rise into a realm of its wise selection and consequent successful use.

The operator who employs porcelain indiscriminately invites disaster. The close student of dental materials will temper his enthusiasm for aesthetics with a more sound knowledge that in restorations on occlusal surfaces where opposing natural teeth are present, the use of porcelain is extremely hazardous. He must never lose sight of the relative advantages of gold, and other filling materials. A close study of individual conditions will aid the wise employment of the correct restorative material.

Conservation of tooth vitality is an insistent demand upon the modern operator. The preservation and restoration of gingival contour is a demand hardly less important than the first. The modern porcelain worker is equipped to fulfill both demands in an artistic manner with a minimum sacrifice of tooth tissue.

Always with the consent of the writers, the author has employed the publications of other authorities on this large subject. The work of Capon, Van Woert, LeGrow, Thompson, Bridge and Vehe is too well known in this connection to require further mention here. To these men and to many other helpful friends the author renders his grateful thanks. The reader will do well to remember that the labor of no one man can be completely original, and that the real success in any field can come only through the earnest labor and cooperation of many men.

The material presented in this volume has been collected by the author at various periods during the past three years. The labor connected with it has been considerable, as sincere effort has been made to publish only essential knowledge of a subject which is obviously vast in its scope. For the detailed preparation of the manuscript and for the arrangement of the book the author is indebted to Dr. John W. Cooke, of Boston, whose close cooperation and assistance have been of great value.

J. F. Hovestad.

Boston

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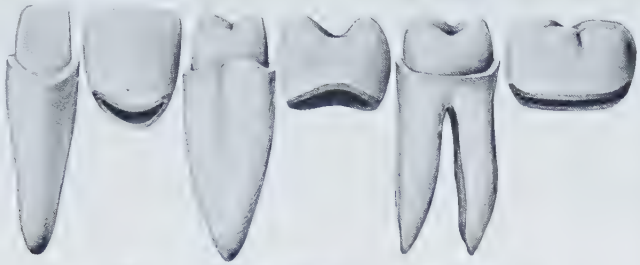

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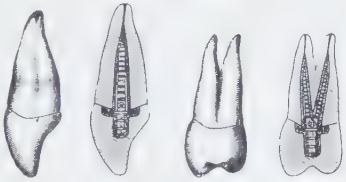

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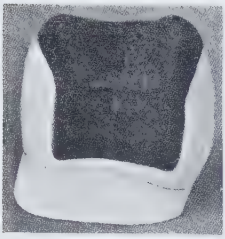


(Courtesy of Dr. W. Clyde Davis.)

Class IIB.

Class IIC.

PRACTICAL DENTAL PORCELAINS

CHAPTER I

PRELIMINARY CONSIDERATIONS

Examination of Patient.—The wise practitioner will consider seriously several factors before commencing any work of restoration in the mouth. Close attention should be given to radiographs, if possible of the entire mouth, and certainly of the immediate area to be restored. Careful inquiry should be made into the patient's general condition: should apical disturbances be present, determine if their correction, in view of this general health, is advisable.

Occlusion, Tissue Conditions.—Remembering its clear importance in the success of any extensive work, occlusion should be studied, watching for evidences of traumatism, faulty contact-points, poorly contoured fillings, badly fitting dentures, bridges and crowns. Note the general mouth hygiene of the patient: if extensive porcelain restorations are contemplated, have the general foundation in the other teeth and surrounding structures in as healthy a state as possible.

Study Models; Labial Models; Classification.—The work of preliminary examination should be continued on study models of the entire mouth, in connection with which should be recorded the facts gathered from direct observation in the mouth itself. For the amplification of detail, labial models are of distinct value. Small irregularities, minor stainings and markings can be noted, and their presence in direct view on labial models furnishes the porcelain worker with a definite foundation on which to build an

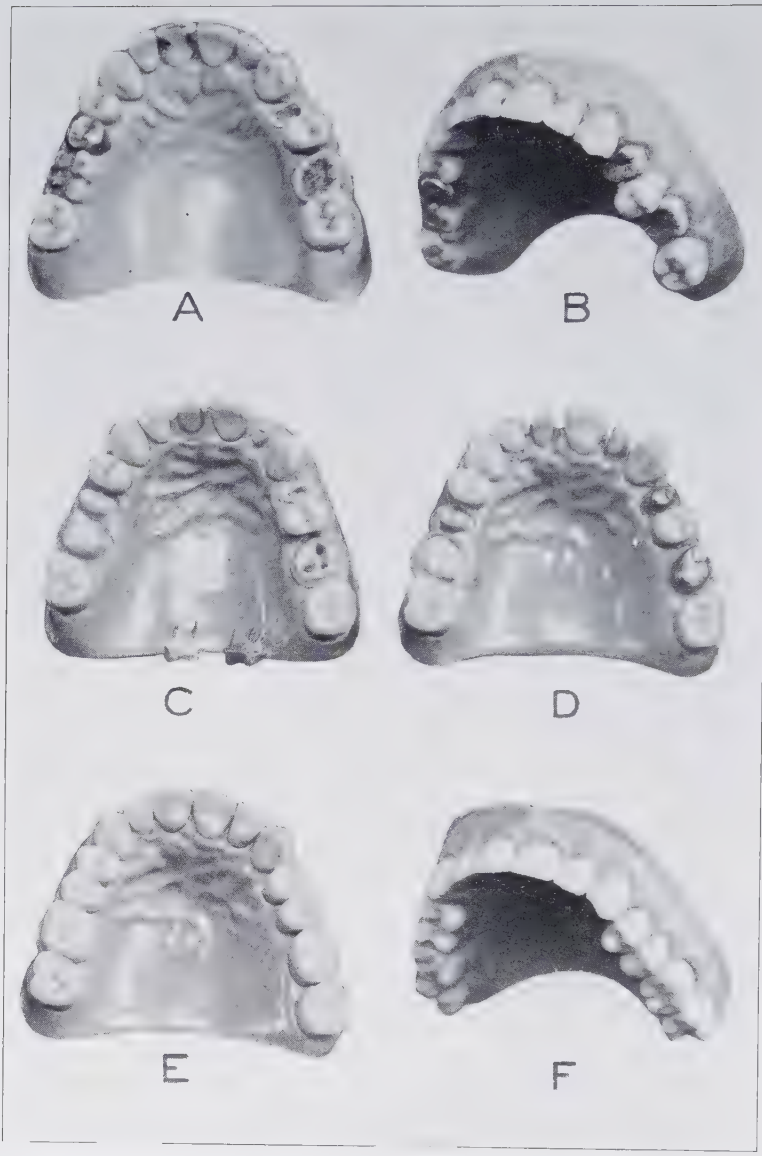


Fig. 1.

(For description, see opposite page.)

Description of Fig. 1.

Specimen Illustration of the Possibilities in Porcelain Jacket Crown Construction.

For demonstration purposes the teeth on the upper left are considered pulpless, while those on the upper right are considered vital. The pulpless teeth for jacket crown treatment are the lateral incisor, first bicuspid and first molar, all on the upper left. The vital teeth are the central incisor, second bicuspid, and first molar, all on the upper right.

Fig. 1, A and B—The case as presented. Left upper lateral has porcelain post crown from which gum tissue has receded. Left upper first bicuspid and first molar pulpless and badly broken down by decay. The right central weakened and disfigured by approximal fillings, the second bicuspid badly crowned with gold, though vital, and the first molar, while vital, has been broken down by excessive filling and decay.

Fig. 1, C and D—The vital teeth on the upper right present typical jacket crown preparations. The left lateral has been prepared, leaving the original porcelain post crown in position. The bicuspid and molar on left have been prepared for castings which are shown with their respective preparations in C, and in position in D.

Fig. 1, E and F—Two views of the finished case, a result harmonious with its surroundings and correct in anatomical detail.

artistic restoration. The type of restoration should be decided upon with the aid of the classification which has al-

Fig. 2-A.—Normal occlusion. Buccal view. (Turner.)

Fig. 2-B.—Normal occlusion. Lingual view. (Turner.)

ready been furnished. Obtain a clear conception of just what work is demanded and the successive steps become simple, and the ideal restoration more nearly realized.

Anesthetics.—For anesthesia for vital tooth preparations, the author prefers local anesthesia by the infiltration method wherever possible and nerve blocking for others. Professional literature on this subject is too complete to require further mention in this book, further than to refer the student to the many good publications dealing with this important field.

Disputed Details of Preparation; Anatomical Articulators; Direct Versus Indirect Methods.—The author is aware that the technic herein outlined is but one of several successful methods. In the preparation of the full shoulder

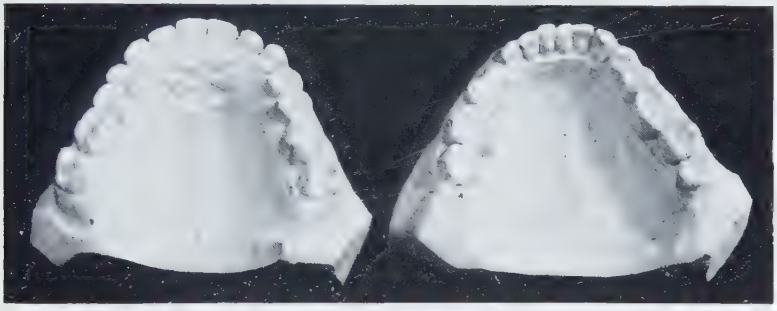


Fig. 3.—Excessive destruction by caries corrected only partially by fillings. Bite raising essential to restore correct occlusion.

coping, or jacket crown, controversy has arisen concerning entire removal of the coronal enamel and of the subgingival enamel edge. Furthermore, opinion differs as to methods of protection for prepared teeth. This volume is not the place for the discussion of relative values. It is sufficient to say that any technic is good which produces the desired result at no harmful sacrifice of tooth tissue and tooth vitality.

For extensive restoration the porcelain worker is confronted with a further question as to a standard anatomical articulator. Recent investigation has apparently demonstrated that an operator skilled in the use of a recognized

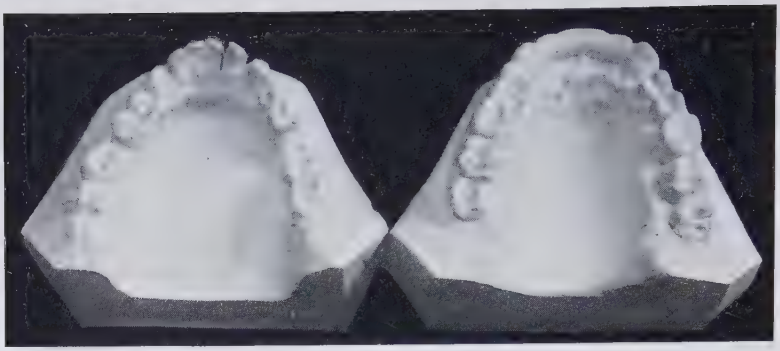


Fig. 4-A.—Study model of case before treatment.

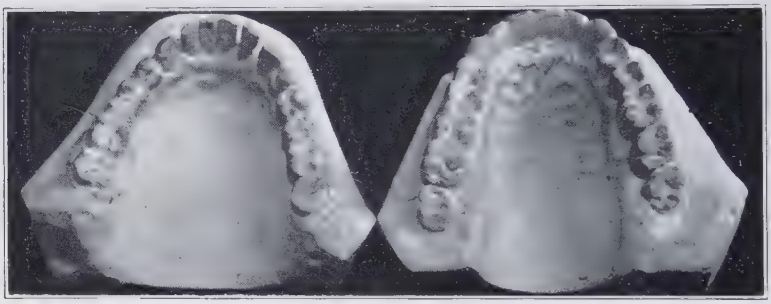


Fig. 4-B.—Case completed. Shell crowns replaced and bite corrected with jacket crowns and two lower jacket crown bridges.

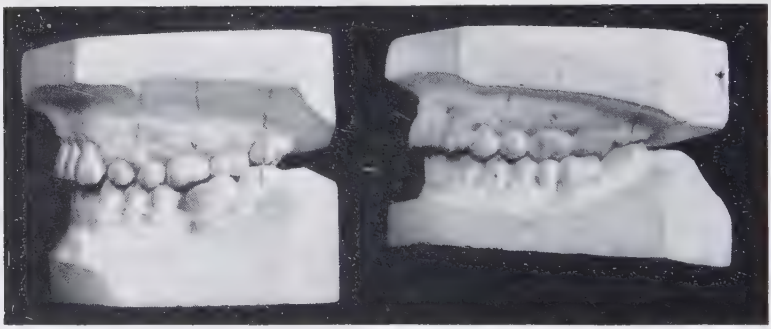


Fig. 4-C.—(Left) Buccal view before treatment. (Right) Buccal view after treatment. Molar gold shell crowns replaced with porcelain restorations.

instrument can attain success favorably comparable with the work of any other expert with a different instrument.

Consideration is given in detail in succeeding chapters to direct and indirect methods for porcelain restorations. The reader is again reminded in this connection that there is no one method which can be used. Errors and apparent failures in porcelain building and fusing can be corrected

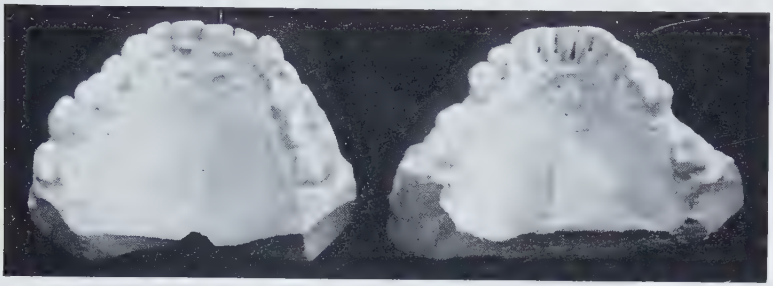


Fig. 5-A.—Study model of case before treatment.

Fig. 5-B.—Bite corrected and occlusion restored with jacket crowns and porcelain bridges.

with the indirect methods in the absence of the patient. If the patient's time is of any consideration, the indirect method undoubtedly has its advantages. It is, however, largely a matter of individual skill and preference.

The Operator's Actual Use of Porcelain Bodies.—The demands of a busy practice have caused the development of commercial laboratories. Many porcelain workers complete the entire restorations themselves; it is the opinion of

the author that it is an excellent plan for the student of porcelain to be familiar with the laboratory aspect of his cases. Except for the specialist, or the exceptional man, personal completion of a case is seldom possible. Good laboratories are available where excellent work can be done, provided the porcelain worker becomes the master of

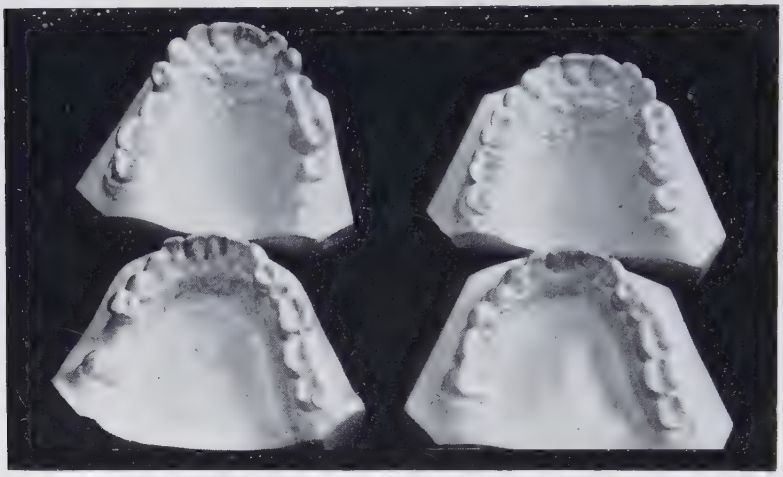


Fig. 6-A.—(Upper) Maxillary arch showing correction of elongation and malocclusion. (Lower) Mandibular arch restored.

Fig. 6-B.—(Left) Buccal view before treatment. (Right) Buccal view following treatment.

his own operative technic. No chain is stronger than its weakest link; the foundation of all this work, the tooth preparation, must be exact, before either the individual operator or the commercial laboratory can produce exact restorations.

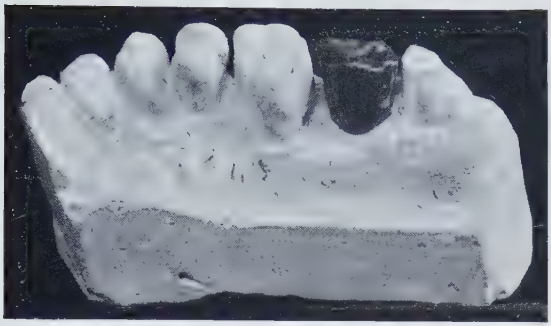


Fig. 7-A.—Left upper molar crown: no contact points and no cervical contour.

Fig. 7-B.—Case corrected with two molar jacket crowns and an inlay in the bicuspid.

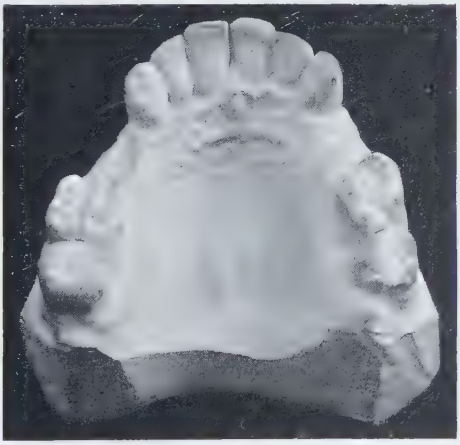


Fig. 8.—Study model. Four anterior post crowns, with poor approximal contact, no cervical contour, with resulting destruction of gingival tissues. These post crowns were prepared for jacket restorations, and the new crowns were fitted over the remaining stumps.

CHAPTER II

THE FULL SHOULDER COPING (JACKET CROWN) FOR VITAL TEETH

Fundamental Principles.—In the effort to produce an exact reproduction of the natural tooth in shape and color the operator should bear in mind the following cardinal points, aside from the more mechanical matters of technic:

1. Remember the anatomical relations of enamel, dentine and pulp (Fig. 9, *A-E* inclusive).
2. Make every effort to protect pulp and peridental membrane from injury.
3. Guard against injury to surrounding soft tissues.
4. Perfect a restoration of anatomical detail. (Fig. 10.)

The operator should also remember that a natural tooth, from which the enamel has been removed, approximates, minus the shoulder, the general outline for the preparation for an all porcelain jacket crown (the full shoulder coping). In bicuspids and molars the denuded crown retains decided cusps, in itself an important aid to the success of this restoration in minimizing the danger of exposure, and in strengthening the restoration against lateral stress.

The Operative Field; Arrangement of Instruments.—The original examination of the patient should be called to mind; if it has not already been done, the operative field should be cleared of deposits, and the mouth rinsed with some antiseptic wash. The proper radiographs should be in view; the area is anesthetized, and the complete operating equipment is laid out within easy reach. The assistant is ready with basin and syringe filled with hot water, the saliva ejector is adjusted, and the patient is placed

A.

B.

A and B.—Sections at right angles to each other, showing relation of enamel covering to dentine.

C.

D.

C and D.—Sections in same planes, showing theoretical relation of porcelain covering in jacket crown to remainder of tooth.

E.

E.—Typical anterior jacket preparation.

Fig. 9.—The approximation of tooth form in the porcelain preparation and restoration.

in a position comfortable to himself, and convenient for the operator and assistant. (Fig. 11, *A* and *B*.)

Mesial and Distal Cuts.—With a knife-edged, rubber-carborundum stone, five-eighths inch in diameter, in the straight hand-piece, and working under a steady stream of hot water from the syringe held by the assistant, a cut is started at the incisal edge on the mesial side, at such a

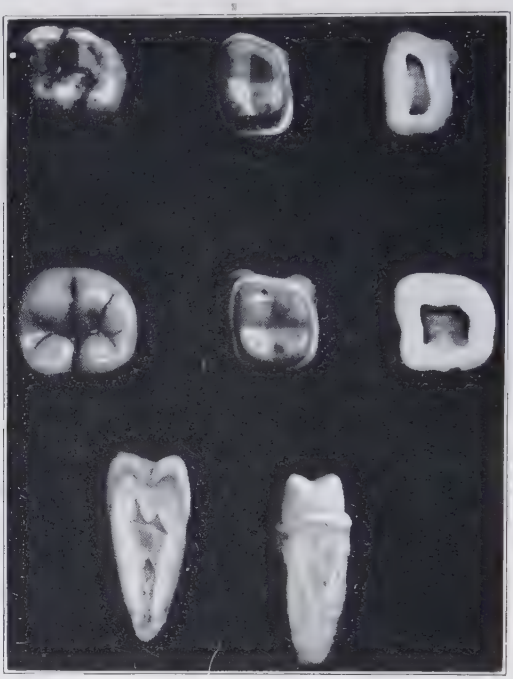
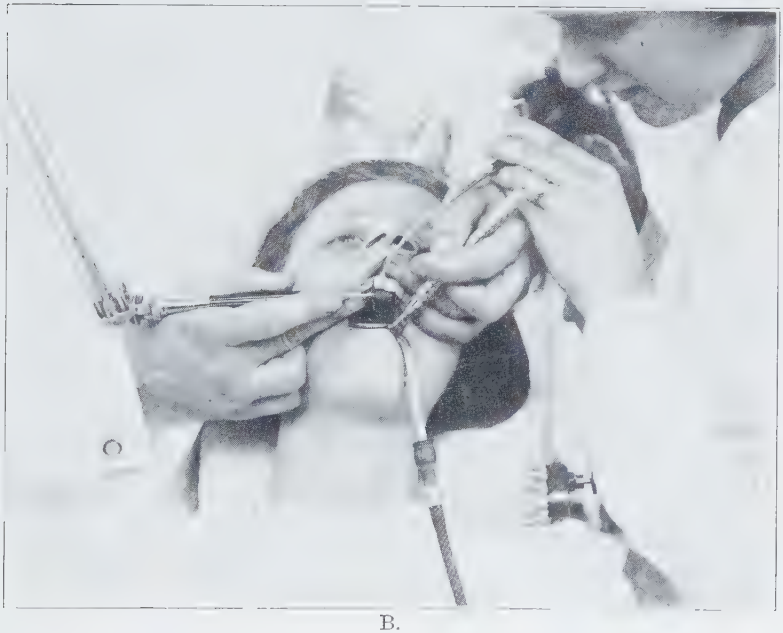


Fig. 10.—Anatomical detail in tooth preparation and restoration.

point that when carried to the gingival margin a clearly defined shoulder will be produced on that side. (Fig. 12, *A*.) It is usually possible to complete this step with a single cut, removing in one piece the mesial enamel. Following an obvious principle for this work, the mesial and distal cuts are made with a slight, though definite taper from gingival to incisal. A second similar cut is produced on the distal surface.

A.



B.

Fig. 11.—Operating position for upper anterior teeth. Note relative positions of engine handpiece, mirror, and water syringe.

Reduction of Labial and Palatal Surfaces.—(Fig. 12, *C.*) A second stone, one-half inch or less in diameter, and thicker than the first is now employed to remove the enamel contour from the labial and palatal surfaces and to outline the cervical shoulder on these two surfaces.

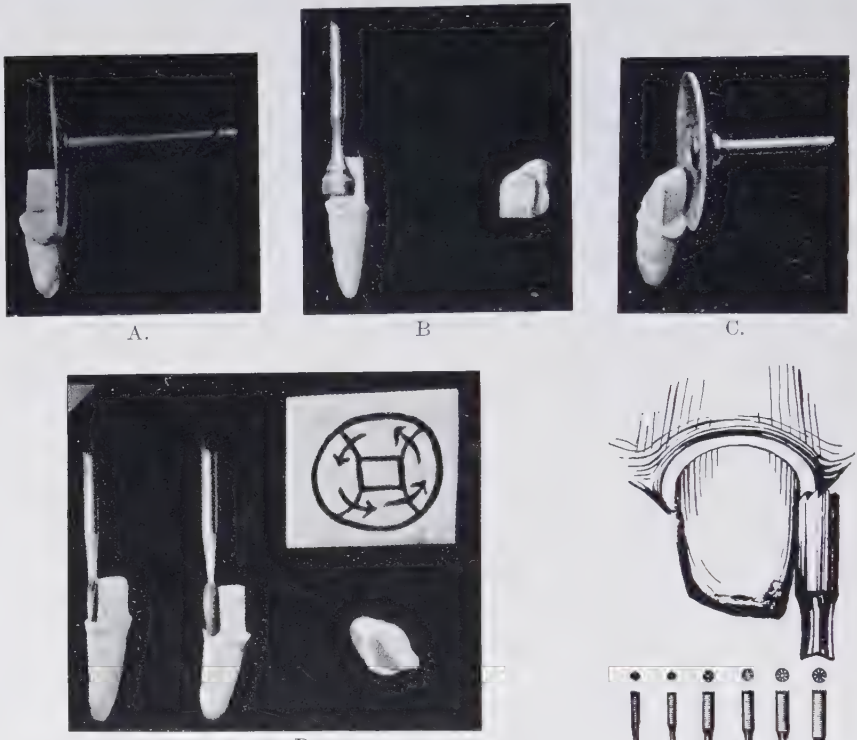


Fig. 12.—Operative steps in jacket crown preparation.
A. The first cut, mesial or distal.
B. Reduction of enamel contour.
C. Rounding of corners.
D. Outlining the shoulder. Insert shows proper direction in cutting for engine instrument.
E. "Clev-Dent" end cutting burs, used for forming the shoulder.

Reduction of Cutting Edge.—A similar stone is employed to remove the incisal edge, or occlusal surface, sufficiently to allow for suitable bulk of porcelain at this point. The preparation should now present the appearance of a pyra-

mid with a flattened top, from whose base is definitely outlined the shoulder later to be fully extended and emphasized.

Removal of Coronal Edges.—(Fig. 12, *C.*) A concave-convex carborundum stone is now used to remove the four corners. Attempt should be made in completed preparation to retain in a general way the outlines of the original tooth in a smaller concentric form: this will facilitate exact reproduction.

The Shoulder.—(Fig. 12, *D.*) With a tapered cross-cut fissure bur reduce the angular outline at the gingival margin and define the shoulder the entire circumference of the tooth. At this point it is customary to carry the shoulder only to the gingival margin, except in cases where caries has extended further, when the shoulder should be extended apically to the depth of the decay. The student will remember that the cutting instrument in the dental engine moves from right to left. It is well in this connection to mention that firm control of any engine instrument, and especially of a cross-cut fissure bur, can be accomplished only by employing the force of the instrument directly against the right to left direction of the bur. Thus in defining the labial shoulder with a cross-cut fissure bur, the direction of the cut should be from right to left, or in the case of a right superior incisor, from distal to mesial. The importance of this point cannot be minimized, as few engine instruments, under careless or ignorant control, can do more harm to the soft tissues than the cross-cut fissure bur. It is further important to emphasize the necessity for steady cutting, not only in its tendency to eliminate undercuts, but in the reduction of unnecessary vibration of the engine instrument.

Completion of Shoulder.—Prior to completing the shoulder it is an excellent method for the operator to fit the impression bands. After the shoulder has been extended beneath the free margin of the gum, to attempt band fitting

at this point is a process not only difficult for the operator, but fraught with some danger to the soft tissue attachments. Band forming is to be described; it is thought wise for the reader to keep the different steps in their correct order.

The shoulder, which has been defined with the cross-cut bur, is now carried under the free margin of the gum tissues with an end cutting fissure bur; this instrument has the great advantage of cutting to any desired depth without lacerating the soft tissue.

Fig. 13.—The finished preparation.

The Completed Preparation; Protection.—At the discretion of the operator, small stones, fissure burs, or paper disks are now employed to finish the preparation, smoothing the surfaces thoroughly, finding and removing undercuts, and satisfying him that his preparation has been exact. The preparation is now washed and dried and its surfaces coated with a resin solution or some other suitable cavity lining. This closes the dentinal tubuli against a possible subsequent infection, prevents afterpain, and reduces pulp shock from thermal changes during the interim between the preparation and the insertion of the completed restoration.

Emphasis on Details.—The author has become accustomed to the aid of an assistant who keeps the field of operation under a constant stream of warm water. It is his opinion that this method is the best: that it is the most convenient is probably not to be doubted. However, whatever method is employed, make certain that the preparation is kept under warm water during the use of stones and burs; this point cannot be overemphasized. The water keeps the stone cool and clean, allowing rapid cutting. It furthermore prevents excessive friction heat, an important factor in eliminating albumen coagulation in the dentinal tubuli, a prolific cause of pulp disturbances.

The reader will do well to note the accompanying illustrations for this preparation: instrument control has already been touched upon in connection with use of fissure burs. Hand-piece grips of proper nature are useful. The student should cultivate a firm supported hold for his engine handpieces, guarding their movements carefully with a firm finger rest, and grasping the shank of the handpiece handle close enough to the working end to eliminate undue leverage. These and many other seemingly minor points of technic become mechanical movements in the skilled operator: an intelligent original conception of the small details of technic will go a long distance towards an ultimate success.

The tooth preparation outlined in Fig. 13 considers a typical anterior tooth. It is well to remember that variations from the normal are the rule rather than the exception. Dental caries makes havoc of many an otherwise simple preparation. The operator should attempt to restore the tooth form of his preparation as closely to the ideal as possible. Decay should be excavated and filled with oxyphosphate cement. It is the opinion of the author that, wherever the place for silicate cements may be, the correction of carious areas in the tooth preparation is not a proper situation for them.

The Impression Bands.—This step should be completed, as already outlined, prior to the completion of the shoulder. Select two seamless copper bands, 35 or 36 gauge, sufficiently long to allow a generous surplus of band; these should be approximately a thirty-second of an inch larger in circumference than the prepared tooth at the shoulder. Festoon one end of each to the gingival outline of the preparation, and disk the edges smooth, to prevent laceration of gingival tissue during impression taking. Make a definite mark on labial surface of bands to prevent later confusion. (Fig. 14.) The student will find that impression

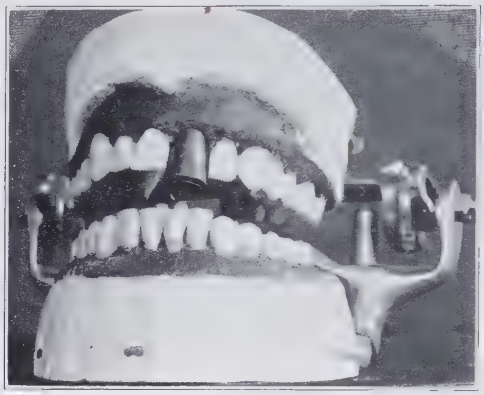


Fig. 14.—The copper band, fitted, festooned, and in position.

taking will be much simpler if the fitting of the bands is done before the shoulder is completed; the preparation at this time is not obscured, and an accurate adaptation is comparatively easy.

The Impression.—(Fig. 15, *A-D* inclusive.) Using dry heat, soften one end of a stick of Kerr impression compound, and warming one of the copper bands, fill completely with compound: vaseline the surface at the festooned end, re-heat this end for a second. With the band between the forefinger and thumb, carry it over the prepared tooth, and with steady careful pressure and with

rotary motion go just beyond the shoulder. Then, maintaining correct position, compress the excess compound at

Fig. 15.—The copper band impression.
A. Poor guidance of band: obstruction at shoulder.
B. Correct position of band.
C. Band and compound in place before compression.
D. Note position of fingers in guiding band to place.
E. Compression of compound.

the incisal edge of the impression. Continue this steady pressure until the impression mass has thoroughly set, and then, using a small napkin to obtain purchase on the smooth

surface of copper, withdraw the band with a pulling motion following the axial plane of the preparation, to prevent buckling and distortion. The author discourages the use of cold water, or ice, to hasten setting of the impression material, as the shock to a vital pulp would be apt to be injurious.

Examination of Impression; Correction of Errors.—Examine the impression thoroughly: make certain that the outline and size of the shoulder is definite. If the shoulder does not show clearly, it is either a faulty tooth preparation or a poor impression. Examine the tooth; if the shoulder is unsatisfactory at any place so demonstrated in the impression, correct the preparation. Dry the original impression, add a slight amount of compound, re-heat over the open flame, and repeat the impression as before mentioned. The shoulder must show clearly and well defined. Poor impressions are due to the following factors:

1. Poorly selected and fitted copper bands.
2. Failure to guide impression band over the shoulder.
3. Incorrect compression and cooling.

All these factors are easily detected and as easily corrected.

Bite Relations.—Just as an accurate impression is essential for an exact reproduction, so is the exact relation of the amalgam die to the adjoining and opposing teeth of paramount importance. Ordinary wax, compound, or plaster impressions are most unsatisfactory, the first two being easily distorted, and the last named fracturing at the most frail and usually the most important points. There are two satisfactory methods of obtaining bite relations.

1. Fit and festoon a copper band over the prepared tooth. Take impression of tooth as directed, using soft paraffin wax; allow wax to harden, and, over the band, including several teeth on each side of the prepared tooth, take a plaster impression. (Fig. 16.) Upon removal of impression, make certain that the copper band, with its wax con-

tent is firmly seated in its place before making the model. The operator may now complete the wax bite, in the manner to be described. (Fig. 17.)

2. With the second copper band, take a Kerr modelling composition impression of the prepared tooth; a stiff mix-

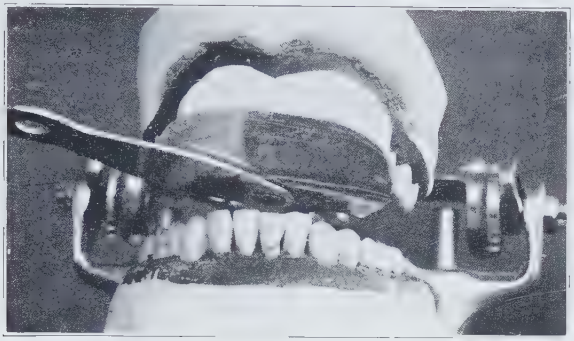


Fig. 16.—Plaster impression over copper band wax impression.

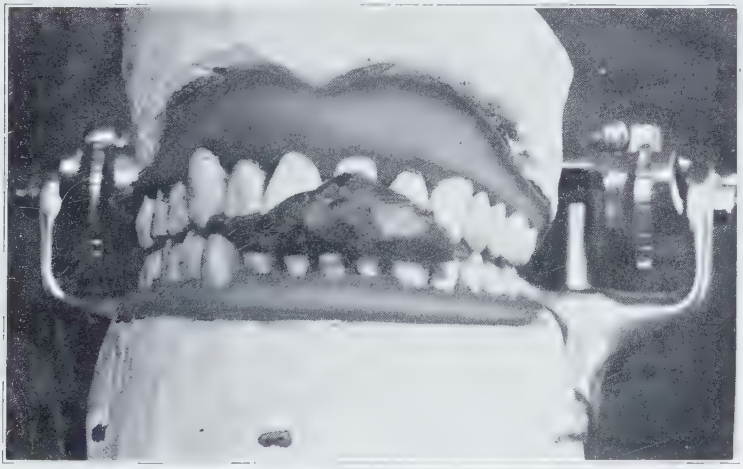


Fig. 17.—The wax bite, with No. 40 tinfoil between the two layers of wax.

ture of quick setting cement is forced into this impression, and a wooden dowel or broken match, for convenience in handling, is set into the cement; as soon as cement is hard, remove the compound, leaving an approximate model of

the prepared tooth. Trim cement to shoulder; burnish a 40 gauge tinfoil matrix over preparation; remove overhang in shoulder region; reinforce matrix to the shoulder either with sticky wax or with cement. Insert this matrix to place in the mouth and take a plaster impression as in method No. 1.

Taking the Bite.—(Fig. 17.) Soften sufficient paraffin pink wax to cover desired area on each side of prepared tooth, and cover it with No. 40 tinfoil; press the wax side about the prepared tooth, and adapt remainder of wax to adjoining teeth; have patient bite into the tinfoil, which prevents biting through; allow to set; remove; now add a thin layer of soft wax in the tinfoil imprints made by opposing teeth; replace in mouth, take bite, and when removed, there is a stiff wax bite, which stands little danger of distortion. To make a Spence metal occlusion, the technic is the same, except that modelling compound is used in the tinfoil imprints instead of wax, or with Kerr impression a compound impression may be taken of opposing teeth, Spence metal poured in the oiled impression and this Spence model set into wax bite.

Color Selection.—It is advisable to employ a shade guide containing the colors of the porcelain from which the restoration is to be made. For the most part it is necessary to match and select separately the gingival third and the incisal edges of the adjoining teeth. If the restoration is one of the six anterior teeth, the color selection, as well as shape of crown, should be governed largely by the shade markings and natural shape present in its mate on the other side of the mouth, without losing the effect of adjoining teeth. The labial models recommended in an earlier chapter, and a marked chart, are now of use for marking of detail and minor defects and stains, as well as to record the shape and size of the immediately adjoining teeth.

Protective Coverings; Temporary Restorations.—The reader will recall that the completed preparation has been

impregnated with a cavity lining solution for general protection: further guard against thermal change and infection is necessary during the period preceding the insertion of the finished restoration. There are two good methods of accomplishing this added protection, at the same time giving the patient a temporary restoration which is not unsightly, and which will resist all ordinary demands of wear and tear.

1. A strip of white base plate gutta percha (Fig. 18) the width of the proposed crown is warmed and wrapped about

Fig. 18.—The gutta percha cone method of temporary covering of prepared teeth.

Fig. 19.—Caulk's celluloid tooth forms.

a small, smooth excavator handle, to a size approximating the width of the space it shall fill. This rough tube is trimmed to the outline of the gingival margin, then softened over the open flame, and pressed into proper position and alignment over the prepared tooth. The excess is trimmed away, and rough surfaces smoothed with a pledget of cotton dipped in chloroform. This method requires a little practice, but the result is a covering which is remarkably resistant. When covering two adjoining teeth it is well to unite the two cones, especially so in the bicuspid and molar regions. With this method the operator will find that the gum tissues are kept away from the operative field.

2. *The celluloid tooth covering.* Select a Caulk celluloid tooth form of suitable shape, size and color. (Fig. 19.)

Fig. 20.—Mold guide for selection of celluloid tooth forms.

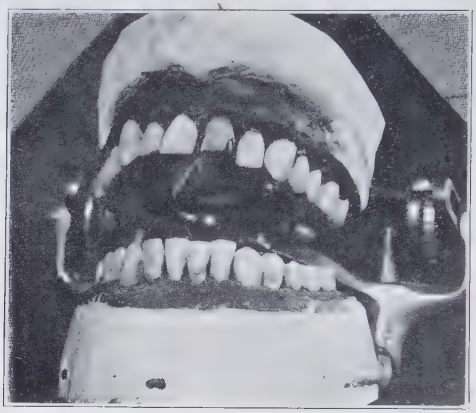


Fig. 21.—Crown form fitted over preparation.

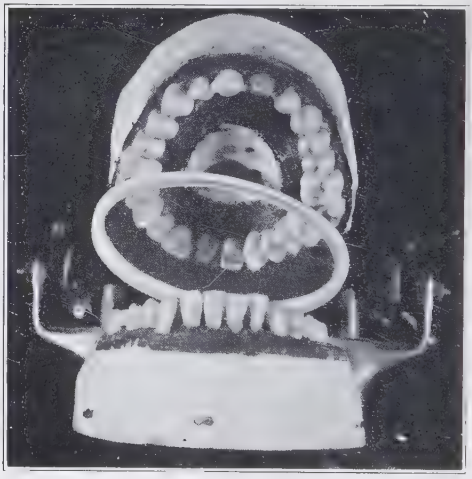


Fig. 22.—Lingual view of Fig. 21.

Festoon to gingival outline, and trim for length and opposing bite. Make certain that there is room enough for the form to cover the shoulder. (Fig. 20.) Prick small holes in mesial and distal corners of form to allow escape of air and excess filling material. Temporary cement may be used, although S.S.W. temporary stopping is easier in manipulation, and fully as satisfactory. Fill the form with temporary stopping, and soften the center with a hot instrument, and press this temporary crown into position; have the patient bite, and hold in place until hard.

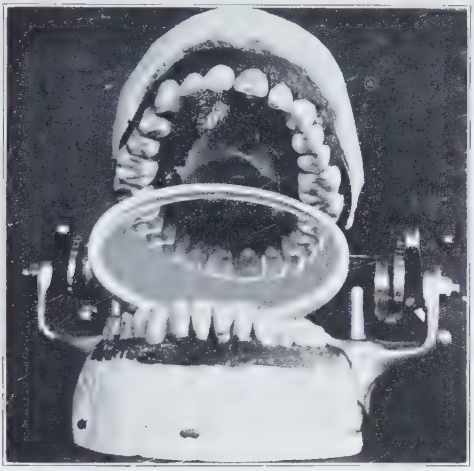


Fig. 23.—Crown form filled with gutta percha.

Color factors in these temporary coverings are seldom ideal, but usually satisfactory. In extreme cases the labial of this form may be filled with the proper silicate cement and reinforced with gutta percha.

Metal Tooth Coverings.—For protection of bicuspid and molar preparations shells of gold or aluminum are of value. The King Specialty Company of Fort Wayne, Indiana, manufactures a 36 gauge aluminum shell, of great usefulness. These shells can be easily adapted to the prepared tooth and make an excellent temporary covering.

Special Protection for Sensitive Teeth.—At the judgment of the operator the temporary tooth covering may be withdrawn after insertion and lined with Carbol-eugenol and zinc oxide, and replaced. Powdered nitrate of silver may be added to this preparation for posterior teeth, but one must be careful in using this on anterior teeth as it may show a dark stain at the gingival border of the preparation. This palliative treatment for sensitive teeth is usually quite satisfactory.

An exceptionally artistic method for temporary restorations and one a favorite with the author is the use of the celluloid tooth forms with two shades of silicate cement. The crown form is fitted as usual, except that no holes are punched in the incisal corners. The assistant mixes one shade of cement, while the author prepares the second. The silicate is placed in the crown form with a small toothpick, the predominating shade toward the cervical, and pressed to place, being held there until set. This method requires some practice, but has proven of great value in those cases where special care must be taken to mask the appearance of anything artificial. The removal of these forms is extremely simple; the form is slit with a fine knife, and the incisal is cut with a knife edged disk; the cement is then removed easily, usually in three pieces.

CHAPTER III

LABORATORY TECHNIC

The Amalgam Die.—The copper band impression is wiped clean with alcohol, and wrapped with white paper, allowing sufficient length and diameter at top to permit surplus of amalgam at root end, and visible access in packing. (Fig. 24.) The paper-wrapped impression is now invested in a large paper cylinder filled with plaster, even with apical extremity of the first paper cylinder. This allows a firm surface against which to force amalgam into the impression. Any good model alloy from which the operator is accustomed to get good results is suitable for the amalgam die. The alloy is thoroughly triturated and is packed into the impression under firm pressure, small pieces of flowing consistency being rotated to place, and followed by larger and stiffer pieces until the cylinder has been filled. Excess mercury is removed from time to time with cotton or bibulous paper and pliers, and the final packing should be done under mallet pressure. A cone is built at the top to allow for still larger excess apically in the die. Several hours should be allowed for firm setting, usually overnight, before removal.

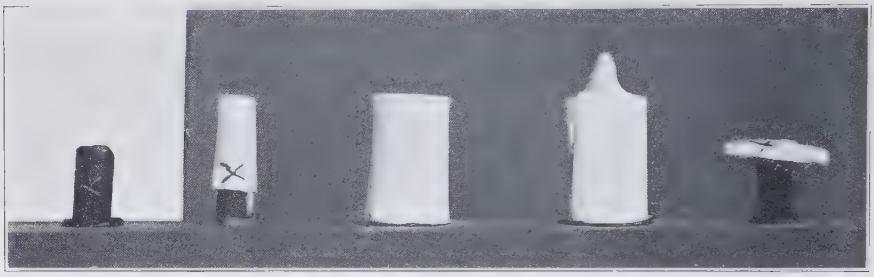
Upon separation from investment the amalgam die should be roughly trimmed to root shape, the area immediately beyond the shoulder being carefully trimmed to taper slightly towards the shoulder for a millimeter or so, so permitting easy withdrawal of the matrix material. The cutting of the die to shape is best accomplished with an abrasive wheel on a lathe. (Figs. 25 and 26.)

Placing the Die; Plaster Models; Placing the Bite.—(Figs. 27, 28 and 29.) The labial of the die is now marked

with a cross for identification, and the die is carefully settled to its place in the impression; flow a little sticky wax around the neck of the die to prevent displacement. Plaster impression should, of course, be treated with some suitable separating material.

The model is now poured in any first-class plaster or in artificial stone. Good plaster of a standard manufacture should be insisted upon.

The model is separated, and the wax bite is placed accurately into position. Trim the plaster model of all unnecessary bulk and pour the articulation.



A B C D E

Fig. 24.—The amalgam model.

A. Copper band impression.
B. Band wrapped with white paper.
C. Band and paper invested in paper cylinder filled with plaster.
D. Amalgam packed and extended to rough root form above plaster.
E. The amalgam model.

To prevent breakage against careless handling in the laboratory, the teeth immediately adjoining the metal die in the impression, may be packed in amalgam; let this amalgam set overnight before completing the model with plaster.

Mention has already been made of the use of Spence metal for opposing teeth; this requires a modelling composition impression for a model. This material melts at a very low heat, and properly worked will not distort the

Fig. 25.—Trimming to shape the root end of amalgam model.

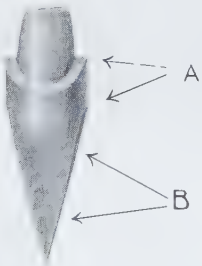


Fig. 26.—Amalgam model, trimmed with sides parallel just beyond shoulder, to allow free withdrawal of matrix apron.

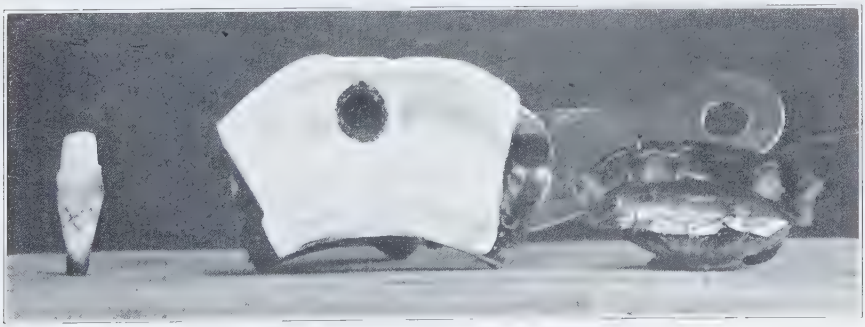


Fig. 27.—The amalgam model, the plaster impression, and the wax bite.

compound. It has an advantage of making a black mark on opposing surfaces which is of some aid in forming correct articulation and occlusion.

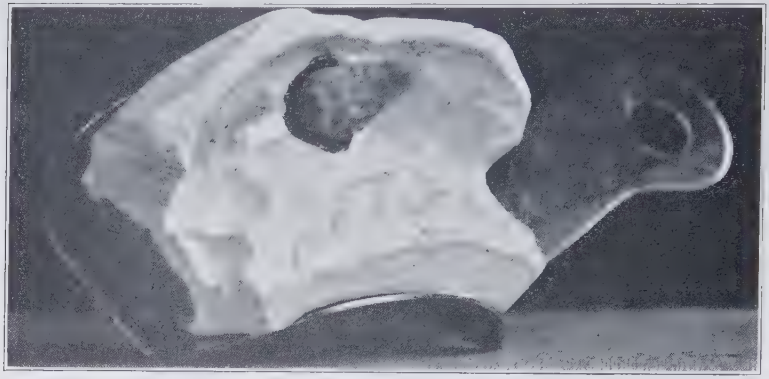


Fig. 28.—The amalgam model in place in the plaster impression.

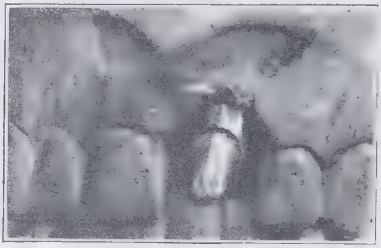


Fig. 29-A.—The model articulated, showing plaster cut away from shoulder.

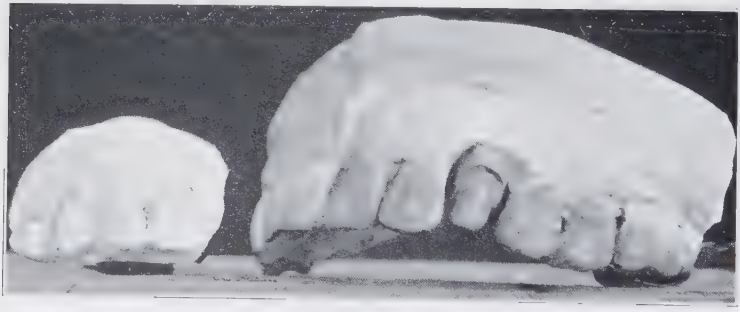


Fig. 29-B.—Models showing prepared cuspid and labial details of corresponding tooth.

Separation of Models; Removal of Die.—The models are opened and trimmed, and the metal die is removed by cutting an opening at the base of the model, and tapping the die free. The area in the plaster model directly beyond the shoulder should be trimmed to allow for free seating of the platinum matrix, and more simple removal of the die.

The entire occluding surfaces, both upper and lower, are shellacked to prevent absorption of moisture from the porcelain during manipulation.

Examination.—It is the opinion of the author that most operators who will depend upon the commercial laboratory for their porcelain building, can complete the laboratory steps thus far outlined in their own offices. There is a tremendous advantage in knowing that model work, and bite placing have been done correctly. It is believed that this work should be done at least under the direct supervision of the operator who has made the tooth preparation.

CHAPTER IV

MATRIX FORMING

General Principles.—Just as the tooth preparation is admittedly the foundation framework for the operative work in porcelain, requiring detailed exactness, so is the platinum matrix, its correct adaptation and handling, the primary requisite for all porcelain building, either from a model in the laboratory, or from the prepared tooth direct in the mouth. Matrix forming is not difficult: like other misunderstood details, it requires only a thorough conception of its formation and a little practice in application for complete mastery and confidence on the part of the user. The beginner should not stint himself in the quantity of foil he uses: patient practice with tinfoil in place of platinum will soon bring an intuitive sense of how much should be used. The platinum foil itself should be $\frac{1}{1000}$ inch thick, and care should be taken in its purchase to obtain as malleable a product as possible. There are several methods for its application: the author has confined himself to two, both good, which are applicable to any type of case for full shoulder coping restorations.

The Twist-Top Matrix.— This type is particularly applicable in cases where the length of the bite allows abundance of room for incisal or occlusal porcelain. The accompanying illustrations (Figs. 30, 31 and 32) consider this matrix in six successive steps, which are so nearly continuous as to require little separation in description. Select a piece of foil of sufficient size, of a shape to resemble an equilateral triangle, whose corners have been removed. Determine on the point in the preparation where the joint shall be placed, which should be always at the spot where the

shoulder and the preparation allow the most room. Holding the foil on the metal die with the thumb and forefinger of the left hand at a point opposite to the location of the joint, adapt the remainder roughly to the die's surface with the thumb and forefinger of the right hand, keeping firm hold in the original position with the left hand. Retaining the same hold with the left hand, draw the edges together at the joint with long-nosed pliers. The matrix will now present the appearance of a rough cornucopia with a fin-like addition extending from the joint, formed of the two loose ends of the foil. Pay no attention to the shoulder at this time. With scissors trim away this fin

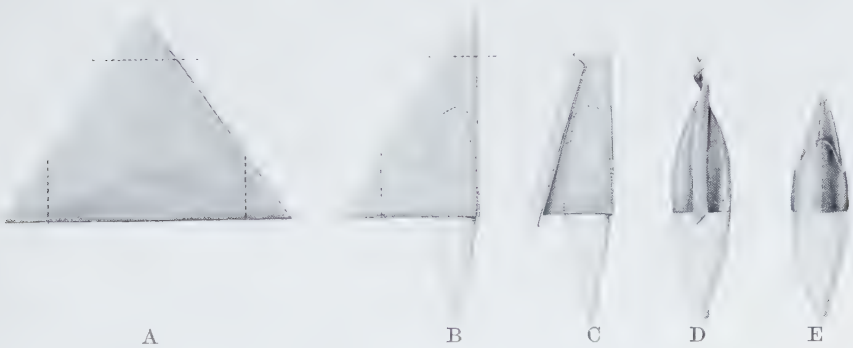


Fig. 30.—The twist top matrix.
A. The platinum foil.
B. First adaptation.
C. Starting the Tinner's joint.
D. Twisting the top.
E. Burnishing completed.

portion, following parallel with the outline of the joint, and leaving sufficient foil to permit twice folding this surplus on itself to form what is known as a tinner's joint. The tinner's joint is now started at the point beyond the shoulder farthest away from the cutting edge of the tooth, the pliers being used to make the double fold in the foil: the final turning down of this two-fold joint is reserved for the burnishing process. Fig. 30 *D* shows the matrix after the tinner's joint has been started, leaving a pointed surplus

towards the occlusal; this surplus is now twisted to a joint, the twist being used in the same direction as that in which

Fig. 31.—Outlining the joint in formation of Tinner's joint in the twist top matrix.

Fig. 32.—Burnishing the matrix. Note hand position, and firm grasp.

the foil has been folded upon itself. Remaining excess is removed with scissors, and burnished smooth. The bur-

nishing process is started from the incisal or occlusal, and continued towards the shoulder, making even pressure at all points. In this manner, the outlining of the matrix shoulder very nearly takes care of itself. Little if any burnishing should be done beyond the shoulder, and no pressure should be exerted against the angular outlines of the shoulder itself, as a tear would be almost certain to develop. The burnished matrix is now swaged, and then removed from the die and trimmed so that it will rest evenly in a vertical position. Difficulties in removal are met by melting sticky wax over the matrix, using enough for a fingerhold, and pulling the matrix free, then burning the wax off in an open flame. The matrix joint at the

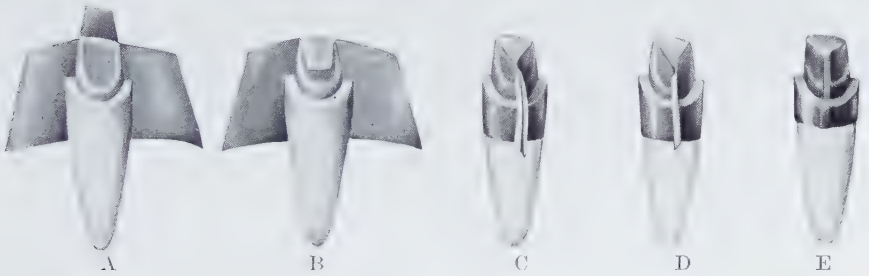


Fig. 33.—The lap top matrix.
A. Platinum foil cut to allow for fold.
B. The flap folded down.
C. The joint made.
D. The Tinner's joint started.
E. Burnishing completed; the finished matrix.

shoulder should be thinned on the die with a fine stone, as the double joint at this point is likely to mar an otherwise perfect fit in the restoration.

The reader can see that this type of matrix demands plenty of space between the edge of the preparation and the opposing bite. It is, however, applicable to almost every normal case.

The Lap-Top Matrix.—This method is somewhat more difficult than the twist-top matrix. (Fig. 33.) It is, however, in experienced hands, more suited to short bite cases,

due to thinness of matrix material at the cutting edge. Fig. 33 shows the adaptation of this matrix in five steps. In step *A*, the original piece may be of sufficient size to include allowance for this lap, the trimming being done after its size has been determined upon in trying the large piece of foil about the die. The lap joint is formed as illustrated in Fig. 33, *B* folding the rectangular excess over the incisal edge or occlusal surface first and then completing the tinner's joint, and finally burnishing in the manner heretofore described for the first method.

The student will remember always to allow a generous surplus for foil beyond the shoulder; this facilitates easy removal, and eliminates drawing the edge within the area to be restored. Swaging, removal and trimming are accomplished in the same manner as for the first method.

Depending on the difficulty of removal from the die, and upon the possibility of complete hand-burnishing, swaging of the matrix is not always necessary.

The author believes that the soldered matrix joint is not necessary. However, before starting porcelain building, the double layer of platinum at the shoulder, formed in the tinner's joint, should be stoned down smooth, to prevent a poor fit of the porcelain at that point.

CHAPTER V

PORCELAIN BUILDING

Preliminary Steps.—Place matrix on die and put die to place in model. Make certain that sufficient plaster has been trimmed away to allow for excess platinum beyond the shoulder, when die is in position on model, with matrix in place. Test matrix for easy removal from die, and for upright position on flat surface. Examine shellacked surfaces of adjoining and opposing teeth: if uncovered plaster shows, treat again with shellac or varnish.

The reader should examine the accompanying illustration of porcelain equipment. (Fig. 34.) The operator should have everything he is likely to need ready and at hand. Have the porcelain bodies already selected in an accessible place; lay out two suitable mixing spatulas, long and short metal pliers, small knives, molding spatulas, small brushes, an alcohol lamp or small Bunsen burner, one or two clean glass slabs, and a bottle of distilled water with dropper. Select fire clay trays of suitable size. Test and start the electric furnace, watch for loose connections and test pyrometer.

First Step.—Mix the first body with distilled water to the consistency of a cement suitable for fixing a crown in the mouth. Remove die with matrix from model, and fill this mixture about the neck, completely around the shoulder. To prevent bunching and running, remove excess moisture with clean white blotting paper, or by passing through the open alcohol flame. Tap the die gently to hasten the even flow of the porcelain mixture, and to eliminate bubbles. (Fig. 36.) Add more porcelain, covering entire surface of the platinum, from the shoulder, over the

Fig. 34.—The author's equipment for porcelain building. Everything necessary is easily reached.

Fig. 35.—The use of porcelain stains. Surface stains are not ideal and are seldom permanent. Important markings are usually deep and should be reproduced, below the surface of the enamel layer of porcelain.

Fig. 36.—Elimination of moisture from porcelain over alcohol flame.

Fig. 37.—Burnishing the porcelain towards the shoulder for thorough condensation and smoothness.

occlusal surface or incisal edge. Continue to remove excess moisture as described to prevent mixture from becoming unmanageable. Add and pack the porcelain towards the matrix for thorough condensation. Attempt to reproduce appearance of the natural tooth denuded of its enamel.

When, in the judgment of the operator, sufficient body

Fig. 38.—A finished case in the mouth.

has been added, the restoration is ready for its first bake. Holding the die by the root end, the overhanging edges of the matrix are loosened with a burnishing knife. The matrix may then be removed with the fingers if care is used. The operator may try the die and matrix on the model if so desired, to test for too great a bulk at any point. He should be careful to remove any porcelain which

may have collected on the matrix apron; this may be done with a fine brush.

The matrix is now placed upright upon a fire-clay tray, and is set on top or in front of the hot electric furnace until all moisture has been eliminated. To place a moist matrix in or near a hot furnace without drying out would result in steam formation and in flaking off of part or all of the porcelain which has been built on. When the moisture has been driven out and steam formation has ceased, place tray with a firm hold, in the center of the furnace, with long pliers. Keep the door of the furnace open for a minute or so, to provide a more gradual firing of the body. Then close the door, and at intervals of a few minutes, advance the heat regulator until a temperature sufficient for a biscuit has been reached. Return the regulating switch to the lowest notch, open the door, and with a firm grasp on long pliers, remove the tray and place it in front of door. The furnace door is now closed, and the regulating switch advanced to maintain high heat for the second firing. Allow the matrix to cool thoroughly before continuing with the second step.

Second Step.—Examination of the biscuited porcelain will now reveal cracks, appearing in several places, mostly, however, at or near the shoulder. These cracks are moistened with distilled water and filled to their depth with the porcelain body used for the first firing. Attempt, at this point, with the body porcelain to get very close to a sufficient thickness to restore cervical contour. Return to furnace for a second biscuit.

The matrix is returned to the die, and the die is inserted to place in the model. Using a clean spatula, build the enamel porcelain, in same consistency as before, over the entire matrix to the desired shape and occlusion. Considerable excess is built on, occlusion and articulation are tried, and the restoration carved or patted down to proper form with suitable instruments. Keep the porcelain under con-

trol by removing excess moisture with clean white blotting paper or by passing it through open flame; the die does not need to be removed from model. In this manner, extremely minute and delicate additions may be made, the porcelain being added almost as a drop of liquid, then condensed with spatula and dried in the open flame.

When the desired form has been attained, push the metal die from its place through hole in plaster model, the completion of this step being carried out away from the model. Deficiencies in mesial and distal surfaces are filled either with spatula or small brush. The restoration is again dried in the open flame and all surfaces are smoothed with the fingers and a fine brush. Return the restoration to the model and correct any errors which may be evident. Complete final smoothing and brushing, and remove matrix in same manner as for the first biscuit. Biscuit the restoration as in step one, allow to cool, remove from the tray, and place on the die.

Third Step.—Further cracks or imperfections should now be corrected in the manner already described. The restoration is always built up with a slight excess in length, and for contact points, mesial and distal. It is again carried to the furnace and allowed to fuse but not to glaze. Afterwards, it is again tried on the model, and sometimes on the preparation in the mouth, testing for occlusion, contact points, and general appearance. Should grinding be necessary, all traces of grit and other impurities should be thoroughly removed with a good washing powder, such as "Dutch Cleanser." Neglect of this detail will cause carbon deposits and other discoloration in the finished product. The restoration is for the last time placed in the furnace and baked to a glaze. (Fig. 39.) If in any case the operator does not feel sure that either the occlusion, the contour or contact is perfect, and that either or all may have to be reduced by grinding or added to with porcelain, it is best not to fully glaze the crown, but to cut

off the platinum foil overhanging the shoulder and try the crown on the tooth with matrix in place. The porcelain may now be ground to meet conditions, or more porcelain may be added, returned to furnace for final full glaze, foil matrix removed, and cemented to place in the mouth. For jacket crowns with dummy attached, for large restorations,

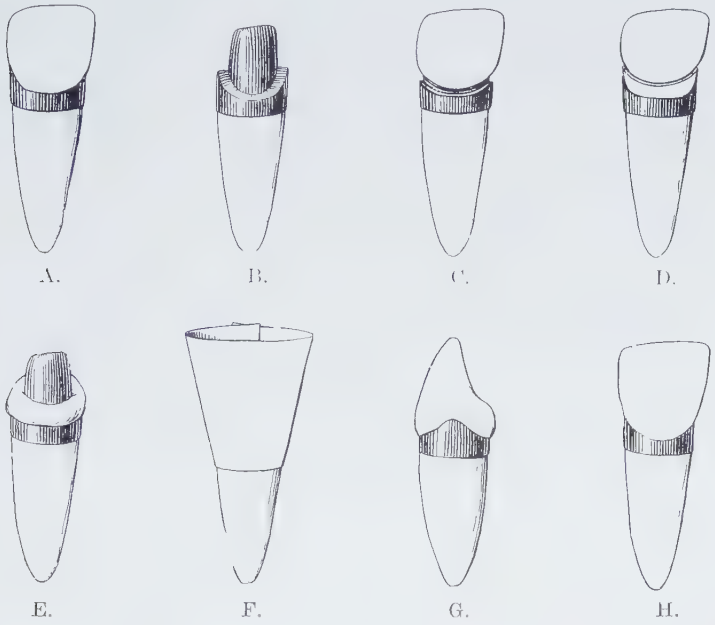


Fig. 39.—Showing various methods of counteracting shrinkage during porcelain building.

A. Porcelain built to shape, depending on thorough burnishing and long matrix apron to overcome shrinkage.
B. Matrix in place, showing wide apron on which author depends to control and overcome shrinkage of porcelain.
C. Area about shoulder, either treated with shellac or cut free from porcelain. During fusing shellac burns out, leaving shoulder free and preventing shrinkage at this point, permitting reburnishing.
D. Unbaked porcelain divided at point between shoulder and tip. It is claimed that shrinkage takes place in both directions away from the cut.
E. Roll-shaped building for first bake. Porcelain shrinks at will; matrix is reswaged and reburnished.
F. Paper cone method. Porcelain added and condensed through the cone. Cone is then removed and the carving is done.
G. Showing excess cervical contour in unbaked porcelain.
H. Labial of finished crown.

for raising the bite, or in restoring contour or contact to or with the adjoining teeth, it is most advisable, in fact in most cases necessary, to try in the restoration before removing the matrix and before glazing the porcelain. If the working model is injured, it is best to take a new plaster impression with the porcelain crown or bridge restoration in place before removing the matrix. This will permit cutting off or adding porcelain where needed.

The reader will understand that there can be no absolute rule for porcelain fusing. The beginner may find additional baking necessary to complete his restoration. He should remember, however, that too many fusings at a high temperature will not only destroy detail, but will actually bleach a color which might otherwise be perfect.

Many cases require detail work in shading and staining. The student is referred elsewhere in this volume for information on tooth staining. The author believes that the best results can usually be obtained with a careful blending of two or three colors, and not from attempts at fine details through a series of four or five shades.

This method of porcelain building is but one of several. Certain operators consider it essential to clear the entire region of the shoulder after adding and biscuiting the first layer of porcelain, to prevent distortion of the matrix at this point; it is also believed that this will facilitate additional burnishing of the matrix to the shoulder after the first firing. (Fig. 39.)

Another method is to coat the shoulder of the matrix with shellac before commencing to build on the porcelain. This shellac burns out completely during biscuiting, leaving the shoulder free. (Fig. 39.) The author, in his work with the full shoulder coping, has not seen the necessity for keeping the shoulder free from the first porcelain body, nor has he been obliged to reburnish the matrix at the shoulder following the first bake. If sufficient overhang of the matrix is provided at the shoulder, there is no dan-

ger of distortion or pulling away at this point. If this matrix surplus is too little, distortion and pulling away is almost inevitable, even though the shoulder is kept free from porcelain. (Fig. 39.)

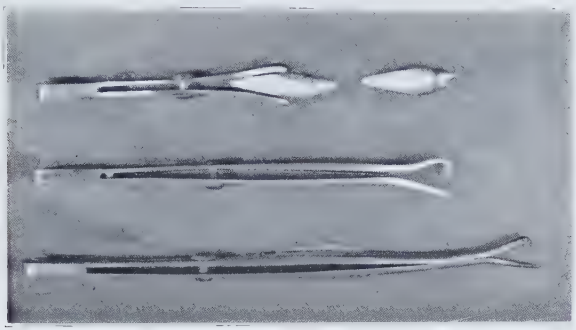


Fig. 39-I.—A useful die holder to facilitate easy handling of matrix and model. This appliance may be easily fashioned by the operator.

One method of securing thorough condensation of the porcelain bodies is to complete the several fusings of the body in the usual manner, and then to wrap a paper cone about the preparation and to pack the enamel porcelain into this cone, removing excess moisture with dry, clean cotton, or blotting paper. When sufficient has been added, the paper is removed and the detail carving completed.

CHAPTER VI

THE PORCELAIN JACKET CROWN FOR PULPLESS TEETH, AND AS A BRIDGE ABUTMENT

The Porcelain Jacket Crown for Pulpless Teeth

It is often desirable to retain pulpless teeth in the mouth, when periapical conditions and the general health of the patient is favorable. Where sufficient coronal tooth substance is remaining to permit the customary full shoulder preparation, the routine procedure may be carried out, remembering one very important exception. Small-rooted teeth, such as superior laterals and bicuspids, and the lower incisors, *must be strengthened* by cementing a wire or post of suitable dimensions into the root canal, extending into the canal and into the coronal preparation sufficient to give the auxiliary strength to these frail teeth, much weakened by loss of vitality and resiliency, and by the shoulder preparation. This post should be cemented into place before starting the shoulder preparation.

Metal Castings.—Where teeth in any part of the mouth are badly broken down by decay, it is nearly always necessary *to build up* with a gold or silver casting. These restorations naturally vary, but should be constructed to meet the individual case, replacing as nearly as possible an ideal preparation for the restoration at hand. (See Fig. 1, *C* and *D*.) Assuming proper periapical conditions, the tooth is thoroughly excavated of all decay, root canals widened to receive necessary post or posts, and platinized gold wires are fitted, extending above the root surface a sufficient length to engage with the wax pattern of the cast restora-

tion. This wax is warmed thoroughly, and is forced to place over these wires, which are in position in the root canals. Chill thoroughly and carve the pattern roughly to desired shape and size. Before forcing the wax into place, the extending ends of the platinized gold wires should be roughened and the extending ends covered with solder, to help the wax to stick and to combine with the gold during the casting process. A casting is made, trimmed, fitted and cemented in the mouth, and the procedure from this point is practically identical with the preparation for the full shoulder coping for vital teeth. These castings can also be

Fig. 40.—Two porcelain jacket crowns over amalgam restorations. The physical changes in the amalgam under pressure caused this work to fail.

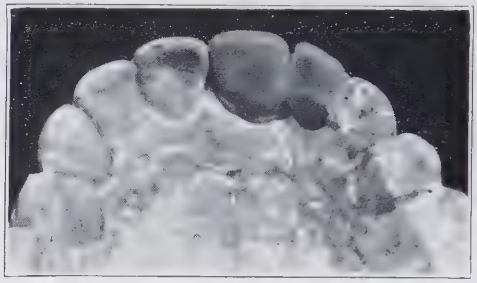
made by the indirect method. However, this choice is left to each individual operator.

The author believes in using gold as the metal of choice in these castings. However, silver gives satisfactory results. Weston's metal and acolite are permissible where great bulk will permit necessary strength. Amalgam should never be used. Fig. 40 shows teeth which have been restored with amalgam prior to preparation for jacket crowns: the amalgam undergoes a physical change due to pressure—amalgam flows under pressure—great shrinkage takes place, and the work sooner or later fails. If a casting

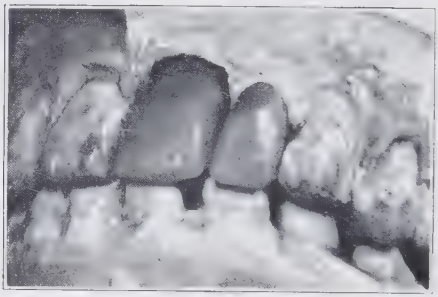
A. B.

Fig. 41.—Indications for interproximal rests.

A. A long overbite demands occlusal or interproximal rests.
B. "End-to-end" bite. No auxiliary support needed.



A.



B.

Fig. 42.—Anterior twin crown restorations, showing type of case requiring some sort of auxiliary anchorage. A, Lingual view showing rest in cuspid; B, Labial view.

is not considered possible, it is far better to resort to a metal post and a cement restoration, than to use amalgam.

The Use and the Treatment of Post Crowns.—It is a frequent occurrence that porcelain post crowns and plain, cast base or banded Richmond crowns become unsatisfactory in appearance due to recession of gingival tissues or to change of color of natural teeth, and other causes. Assuming that these roots are in good condition, any of these crowns may

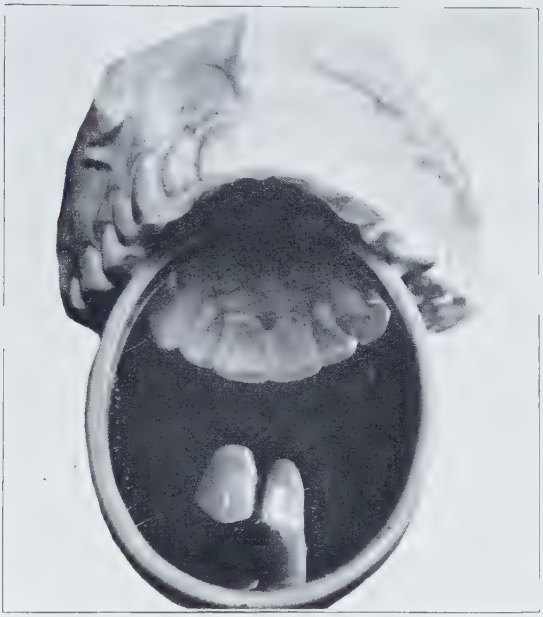
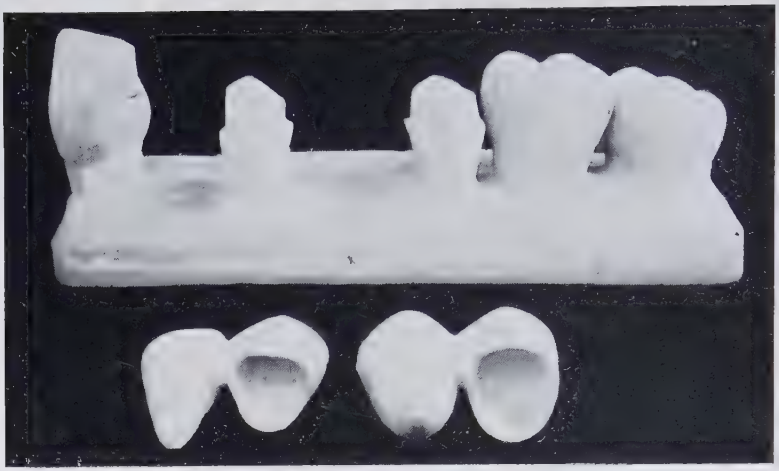


Fig. 43.—Twin crown restoration without supporting rest for "end-to-end" bite cases.

be cut down in size to the typical full shoulder preparation already described. (See Fig. 1, *A*, *C* and *E*.) The band in a Richmond crown will take care of itself during the preparation and may be removed without difficulty when the preparation has been completed to the shoulder. This work, as well as any preparation on a pulpless tooth may be carried out under cold water if desired.



A.

B.

C.

Fig. 44.—Two twin crown restorations: the anterior with rest in palatal of central; the posterior with interproximal rest in distal of cuspid crown. A, Restorations removed from model; B, Buccal view; C, Palatal view.

Porcelain Jacket Crown as a Bridge Abutment

In a very limited percentage of cases the full shoulder coping or jacket crown is an ideal bridge abutment. Practically its only satisfactory application comes in what is known as Twin Crown restorations, namely, the abutment crown is used with an all porcelain dummy baked direct to it, with or without a supporting platinum rest at the other end of the restoration.

Fig. 45.—Porcelain building for twin crowns, showing condition following second bake.

Most common in such types is the replacement of superior lateral and first bicuspid teeth, using the cuspid or second bicuspid as the abutment. In cases presenting a favorable occlusion, no supporting rest is necessary; in instances where such support is necessary, a flattened platinum wire is baked into the dummy, and is adjusted to place resting on an inlay or suitable type of filling for the additional support necessary. Missing first bicuspids are replaced, using the second bicuspid as an abutment, and the rest is

Fig. 46.—Porcelain building for twin crowns, showing detail carving in preparation for third bake.

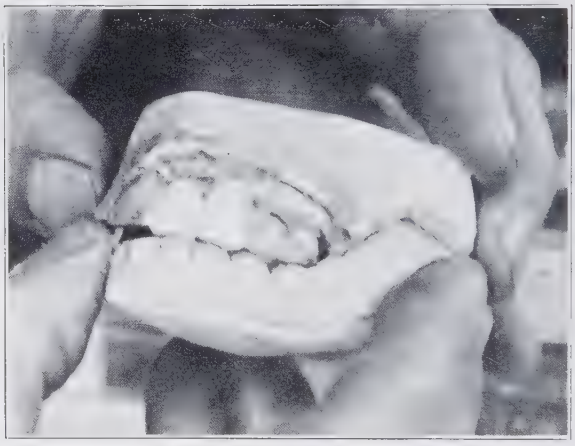


Fig. 47.—Obtaining occlusion for twin crown restoration in preparation for third fusing.

placed to clear the bite in the palatal surface of the cuspid. (Figs. 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, and 53.)

A more difficult but more satisfactory method of prepar-

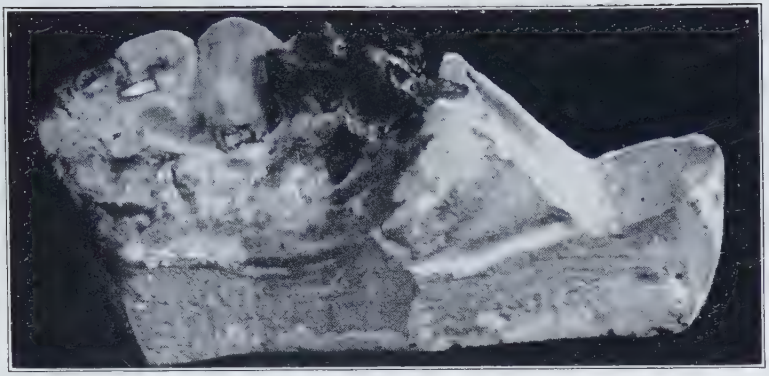


Fig. 48.—Twin crown restoration. Platinum rest in lateral dummy in preparation for third fusing.

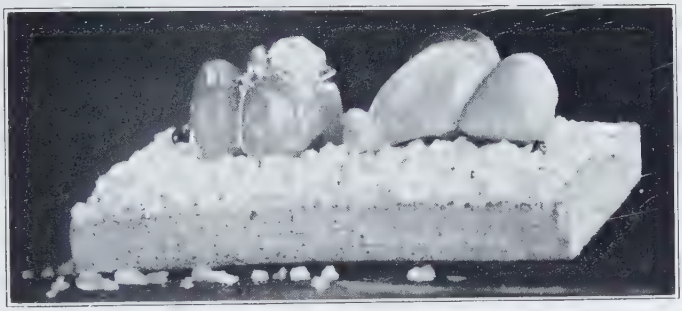


Fig. 49-A.—Position of twin crowns on fire clay tray, resting on coarse silex.

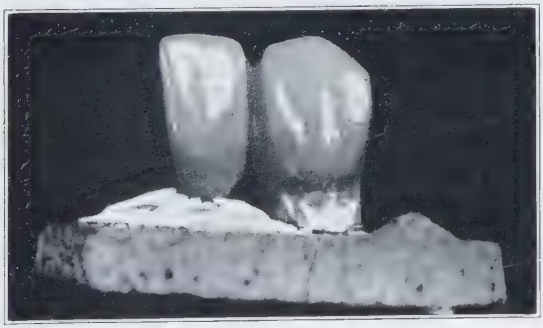


Fig. 49-B.—Position of twin crowns on tray. Matrix apron in contact with tray. The dummy rests on the silex.

Fig. 50.—Twin crown restoration. Porcelain rest at extremity of dummy.

ing this supporting rest is to prepare a gold inlay, with a small hole in its approximating surface: in this hole a round 16 gauge iridioplatinum wire is fitted, the extending end of which is baked into the all porcelain dummy; this restoration must be cemented in one operation, no cement

Fig. 51.—Twin crown restorations. First molar abutment. Occlusal rests on first bicuspids.

being used in the approximal hole, allowing a slight but necessary mobility in the restoration.

Lost six-year molars may be replaced in a similar manner, using the second permanent molar as an abutment tooth, and providing a suitable type of rest into an inlay in the distal of the adjoining bicuspid.

CHAPTER VII

FULL PORCELAIN CROWN RESTORATIONS FOR PULPLESS TEETH

Aside from the familiar jacket restoration for broken down pulpless teeth, and the porcelain anchored full copings for pulpless molar teeth, there are several means of making practical porcelain restorations for cases of this class. Restorations from stock molds are too well known to require amplification here. It will be remembered that there were two general divisions in those stock porcelain crowns which depended for their retention upon pins or posts alone. The first was manufactured with the post an integral part of the crown itself (the Logan and pin and post crowns). The second had crown and post separate (Bonwill, Davis, Justi, and English Tube teeth crowns). Having the advantage that perfect adaptation may be secured with the prepared root surface, the hand baked crowns following these types are very useful where indicated.

For the purposes of this chapter the technic may be considered as for the attached post, or Logan crown; and the detached post, or Davis crown. Root preparations for both these types are made in the routine manner as for any type of restoration which demands a butt joint: the impression technic is identical for both: beyond this the steps vary and will be considered separately.

Impressions.—The preparation has been made, and the soft tissues adjacent to the margins have been properly retracted. Fit and festoon two five-eighths inch 36 gauge copper bands over the prepared root: mark them with a

cross on the labial surface and lay aside. Fit into the prepared canal a metal post so that it will extend about one-eighth inch. Using one of the copper bands, take a Kerr compound impression of the root surface, with the post in position. Make certain that the post releases easily with the impression. Fit another post roughly into the canal, and over it, using the second copper band, take a wax impression. Test this impression for fit, replace on the tooth, and over this, take a plaster impression, including several adjacent teeth on each side. Take a wax bite, using a strip of No. 40 tinfoil between two layers of wax to prevent unnecessary distortion on its removal from the mouth.

Amalgam Die and Articulated Models.—The first copper band compound impression is wrapped with paper or thin wax, invested in plaster, and when cool, is packed with amalgam. Care should be taken not to dislodge the post during packing, and the amalgam should be packed well over the entire length of the post and extended to a root form as in the case of the amalgam model for the all porcelain jacket crown. To prevent union of the amalgam with the post, coat the post with wax or shellac. Allow the amalgam to harden overnight before removing the die from the impression.

Mark the labial of the die with a cross to correspond with the similar mark on the copper band, and shape the root end of the die as for any porcelain restoration which requires foil to extend over the edge of the preparation: make the sides roughly parallel for about a thirty-second of an inch beyond the edge of the preparation, and then taper the remainder to a root shaped cone, for convenience in handling and for proper anchorage in the plaster model. Prepare the articulated model in the usual manner, varnish teeth about the preparation, and remove the die from the model.

The Attached Post Crown

Matrix Making.—Remove the post from the die. Using plenty of foil burnish and swage it to place forming a collar on the sides at least one-sixteenth of an inch long. This will make a perfect foil band and cap. A tinner's fold matrix may be made, forming the foil as though a band, burnishing and swaging over the top, and bringing the ends together on the lingual in the familiar Tinner's joint.

The platinum post has been fitted to the hole in the die, and is now pressed through the foil, its extending portion held in place with sticky wax.

Porcelain Building.—The matrix together with the post is invested, and the first layer of porcelain is built to the matrix and over the post, placed in the furnace and carried to a biscuit bake.

The investment is cleaned away and the matrix and post are placed on the metal die and model. The addition of porcelain is now carried on as for an all porcelain jacket crown.

The platinum foil is removed before cementing the crown to place. No grinding of the base or neck will be necessary. This maintains the natural glazed surface of the porcelain, so beneficial to the investing tissues.

The Detached Post Crown

The matrix is made and the post or posts are pushed through the foil to place in the die. The post is then removed and a strip of matrix foil is worked about it, forming a tube. The joint of this tube is not soldered. It is then carefully pushed through the hole in the matrix, to the depth of the original post. This is waxed to place with sticky wax, making no attempt to close the tube. Remove matrix and tube from the die and invest.

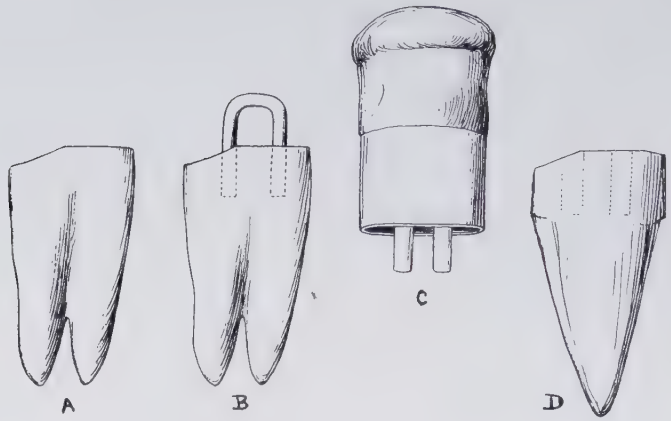


Fig. 52.—The detached post crown. Upper first bicuspid.

A. The prepared root.
B. Posts in position.
C. Kerr compound band impression; posts removed with impression.
D. Amalgam model.

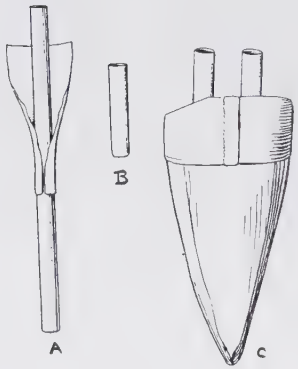


Fig. 53.

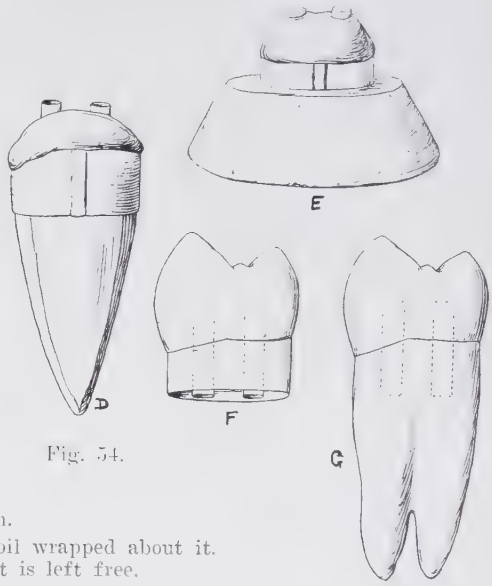


Fig. 54.

Fig. 53.—Foil tube preparation.

A. Crown post. Matrix foil wrapped about it.
B. Matrix tube. The joint is left free.

Fig. 54.—Detached post crown. Foil tube method.

C. Matrix and tubes in place on model.
D. First bake. Tubes are fixed in proper relation to matrix.
E. Matrix invested.
F. Finished crown.
G. Finished crown in place on model.

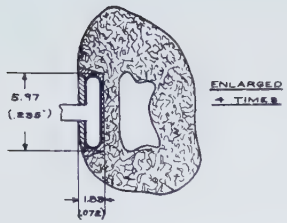
The investment should be allowed to fill the tube. The wax is removed and the porcelain is built as before. After the first bake there is no danger of changing the relation of the tube to the matrix as the porcelain is a firm binder. Investment is removed following the first fusing, and the crown is completed as already outlined. This restoration may be tried in the mouth by cutting off the overhanging platinum apron, but all platinum foil should be removed before setting with cement. The foil in the tube may be drilled out with an engine bur. The posts, previously fitted for their respective places, are cemented to place, in the tooth and in the porcelain, at the same time.

CHAPTER VIII

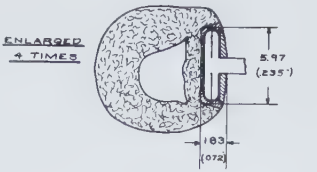
FULL PORCELAIN RESTORATIONS AND THEIR USE WITH THE SEVERAL TYPES OF BRIDGE ATTACHMENTS

Jacket Crown Bridges. -The author has constructed many of these small bridges and has met with good success, using high fusing porcelain bodies in all cases. Some methods are to fuse one or more porcelain dummies to the two adjoining all porcelain abutment jacket crowns. Certain other methods in cases supplying two teeth between two porcelain jacket abutments fuse a dummy to each of the abutments with a 20 gauge platinum wire projecting at mesial and distal respectively of the dummies. The two parts of the bridge are assembled in the mouth, and correct relations taken, and the bridge dummies are connected with each other by soldering the platinum extensions with pure gold and fused over with low fusing porcelain. Neither of the two types of bridges outlined allows individual movement, and for that reason the author does not consider them practical.

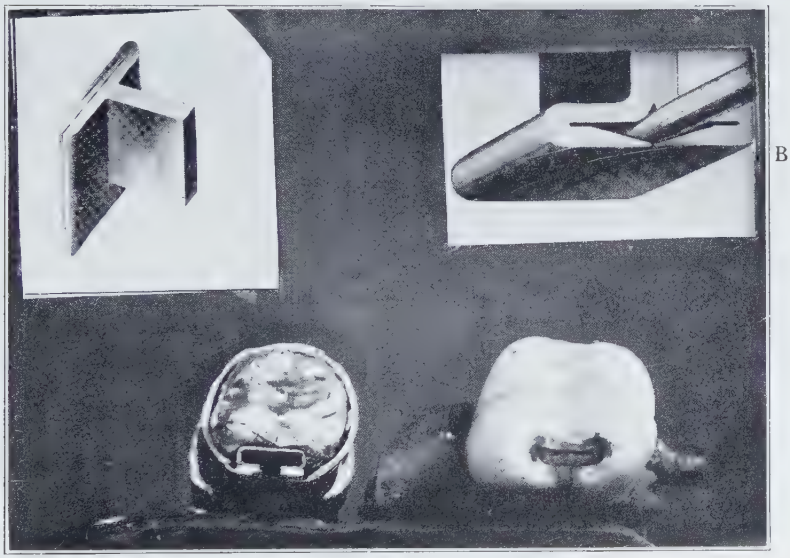
Chayes, Stern and Yirikian Attachments.—In cases where the removable type of bridgework is deemed desirable, the all porcelain jacket crown may be used for the two attachments designated, or for any attachment on the market. The metal dies and platinum matrices are prepared in the usual manner, and correct models are made. The platinum bridge attachments are then paralleled on the model, they are soldered and held in place with a piece of 30 gauge platinum plate and fitted loosely around the platinum foil of the respective abutment. (Fig. 55.) This platinum band should extend the entire circumference of the tooth, and the open ends should enclose the platinum



A



A



B B

C D

Fig. 55.—Bridge attachments for use with porcelain abutments.

A. Chayes' attachment.
B. Stern attachment.
C. Preparation for attachment.
D. Finished abutment, incorporating the attachment.

bridge attachment or tube. These attachments are soldered with pure gold or with platinum solder. The porcelain is then built on in the usual manner.

Great care must be taken to prevent porcelain from getting into the slot or tube of the attachment. Under such conditions of bridge construction, it is the platinum plate

around the tooth which gives the strength, and prevents chipping of the porcelain at the joint of the attachment with the abutment.

Porcelain Bridge Dummies.—Bridge dummies may be constructed to fit the spaces prepared for restoration with the several types of removable bridge. One way of doing it is to carve the dummies in porcelain fusing the platinum male portion of the attachment direct in the porcelain. The most ideal way is by drilling a hole into the porcelain dummy with a diamond drill and cementing the attachment with a suitable extention into the porcelain.

Fig. 56.—A type of clasped bridge for attachment to porcelain abutments.

Abutments for Clasps.—Due to its unlimited range in construction the all porcelain jacket crown may be adapted to meet the requirements of almost any type of clasp attachment known. Where more than one such restoration is employed as a clasp attachment (Fig. 56) such crowns should be paralleled to each other so that accurate insertion and retention of the clasps are possible and easy.

CHAPTER IX

THE PLATINUM BASE CROWN

By William A. Capon, D.D.S.

The platinum base crown (Fig. 58) is made as follows: The tooth or the remaining portion of the tooth is ground wedge-shape, more labially than lingually, because the porcelain requires more room so that it will be in line with the adjoining teeth, while the lingual or palatine portion has only the platinum to be allowed for, so that the occlud-

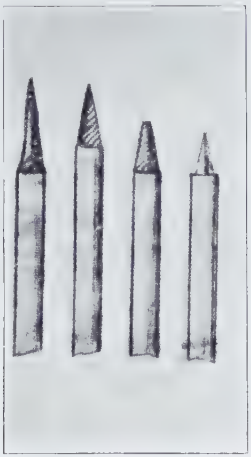
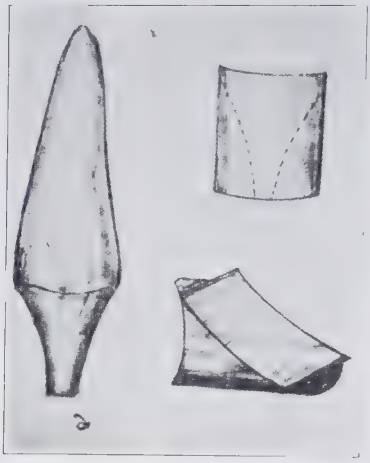


Fig. 57.—An assortment of Evans' root trimmers.

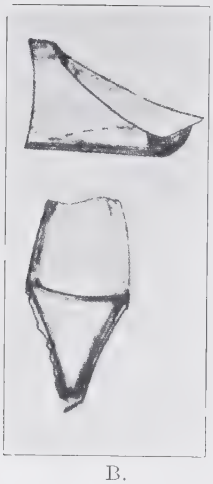
ing teeth do not strike with any wearing force. The tip is cut off about one-fourth and the enamel line is trimmed at the gum margin with enamel scalers or Evans' root trimmers (Fig. 57). These efficient instruments are used on the engine and assist in getting a smooth surface without unduly lacerating the gums.

The grinding should be done with good stones of medium grit, using water very freely. The simplest instrument for

this purpose is the glass medicine dropper, although a water syringe in the hands of an assistant is a convenience. The tooth when trimmed and ready for the jacket will appear as in Fig. 58. Thin disks are used to grind between the teeth making room for the band, also to slightly taper the tooth mesially and distally; but frequently cavities on



A.



B.

C.

Fig. 58.—The platinum base crown. A, B. Tooth preparation: fitting the platinum base; C, Finished crown.

these surfaces will obviate the necessity for much grinding. The next step is to measure the root neck just the same as for a gold shell. Instead of gold, platinum No. 33 or 34 is used and the joints are lapped. Solder with pure gold, using the least amount possible. Gold and platinum solder is preferable and can be used with the ordinary blowpipe if the metal is cut in very small pieces. When the band or tube is made it is fitted to the tooth and the lingual and labial outlines of the adjacent teeth are marked on the tube as a guide to trim those portions so that they approximately fit the wedge-shape of the prepared tooth.

Next give attention to the lingual surface which is ground to the dotted lines on a lathe and then reinforced with platinum or iridioplatinum of the same gauge. Melt a little solder on the platinum square and then place it in the same position as the cut shows. The solder will show a shadow as it melts and is a guide as to the quantity and position of the gold. This portion may be cut out, but not to the exact marked line, because a broad surface attachment is very desirable. The edges of projecting platinum are ground even with the tube surface (Fig. 58), and then the labial or face side of the tube is ground thin to the marked line. This is the most important part of the work and probably the most difficult, for the reason that we require a surface sufficiently thin to burnish to the natural tooth, and if the part is torn or ground through it lessens the porcelain attachment proportionately.

This being done and the tube fitted on the tooth it will resemble Fig. 58, which only shows the outline of the corrugated front. The tongue on the incisal edge may be noted, for this is the secret strength of the crown and cannot be seen after it is made. Press the front of metal to place with a blunt instrument, with the object in view of making it irregular and better adapted to secure porcelain, and the little tip of metal on the lower edge is made by pressing it against a revolving stone, which turns it and

gives it a thin edge in the same movement. After the metal cap is made, and before fitting, place it under the blowpipe and anneal it, also removing any grindings or foreign material that may be present.

The crown is now ready for the porcelain front, which is a thin veneer made for the purpose. This veneer or facing is ground thin and fitted approximately and is attached by means of porcelain body mixed stiff with mixing fluid, which is forced into every part offering attachment, and especially between the tooth tip and the metal point, also into any depression caused by cavities. The veneer is put into position and tapped into place, and the whole is removed with pliers, the excess of porcelain removed and then dried carefully, face down, on a tray in front of the muffle. The crown is now gradually pushed into the furnace and the heat raised to the fusing-point; then gradually cooled until thoroughly cold. The crown is then tried on, and if too full cut from the face and add more body where required and finish, placing the crown on the tray, face up after the front has been attached, heating and cooling carefully as before. The platinum is polished with sandpaper disks and the crown permanently placed, with moderately thin cement, and will appear as in Fig. 59. If the surface of the porcelain has been ground with a stone to reduce the bulk or change its form, it should be thoroughly disked with clean sandpaper disks before the final fusing.

One of the important considerations in making this crown is to note the bite, not because another crown would give better results in certain cases, but because the occluding teeth will be a guide in the making, for certain changes are made in form and material that are of material value. For instance, this crown is described as being made of platinum, and generally that is the metal employed; but there are places in which its combination with iridioplatinum becomes advantageous and sometimes again the whole

metal part is made of iridioplatinum. This harder metal is used on the palatine surface whenever there is very hard contact or a liability to unusual wear, as in a case of a "close bite." When the incisal edge is in direct contact it is advisable to carry the metal to the edge, bending it at the cutting edge to take the force of the bite and having the porcelain anchorage entirely on the inside. In fact, many follow this procedure in all cases, but the porcelain tip is equal in strength and neater in appearance. (Fig. 59.)

Fig. 59.—A finished crown.

It is claimed by some dentists that it is an advantage to have the whole metal portion iridioplatinum, as its stiffness may allow the use of a lighter gauge. This is true when the work is applied to lower incisors, because of their usual closeness, but this combination is very intractable and brittle. Even with much experience it is difficult to grind it thin without breaking and its hardness prevents neat adaptation, as compared with pure platinum. The use of all iridioplatinum is advised if the crown is to serve as an abutment either for a porcelain or a combination gold bridge. It is not generally known that jacket crowns of

this type can be used in connection with a gold bridge. This, however, is recommended, for they can be invested and soldered regardless of the porcelain attachment.

Repairing a Jacket Crown.—The repair most likely to be needed is re-attaching a veneer. This, if not well attached, generally comes free from metal, but if the metal tears away with it a new crown must be made. If the framework is intact and firm in place, loosen all the free edges with a thin, sharp, flat instrument, getting out the cement as much as possible and then use an old scaling instrument as a hook at the neck and in many cases the frame will come away, and with a little straightening be as good as ever. Sometimes a pair of pinchers nipping the free point of the platinum will draw it off when other means fail. When removed, clean all the cement out of it and put under the blowpipe, making it ready for new porcelain. Stoning the surface will assist in securing better attachment. If the same veneer is used all of the old porcelain should be ground away and put in the front part of the muffle for a few minutes to burn out any impurities; then proceed as if the crown were new. The time usually allowed for this repair is an hour.

An unusual cause making repair necessary is the cutting away of the palatal surface by the occluding teeth. I have had several cases which have required this mending after several years' use and in every case the porcelain was intact. If the crown has worn enough to be easily taken off, clean out the cement, burnish thin platinum or gold-foil on the tooth where the cap has worn through, replace the crown and attach the two with wax; then withdraw them and invest. Solder with twenty- or twenty-two-carat gold and re-cement the crown. It will be none the worse for the repair and will probably last many years longer if ordinary care is given in the soldering process.

Treating of a Root Through a Crown.—This jacket crown having a thin metal back, provides a ready means of ac-

cess to the pulp canal; this is a point in its favor, particularly to those who claim that a crown capped will surely give trouble unless the pulp is devitalized. Using a crown of this description, therefore, will prove that such is not the case, but when treatment is necessary, lessen its difficulties.

The writer's experience has proved conclusively that healthy pulps will live indefinitely with the tooth ground and covered as heretofore described, and that only a small percentage of teeth covered with this crown require treatment from any cause. Of course a degenerated pulp will die and require treatment, and so trouble will occur with treated roots, and provision for their eventual treatment is good practice. The non-sensitiveness of some teeth, particularly those that have had much filling, is very delusive, and frequently every preparation for crowning has been balked by the discovery of a living or putrescent pulp. In some instances the delay caused by the necessary treatment of a mutilated tooth causes serious embarrassment, but the employment of this class of crowns relieves worriment from this cause, for in either instance the tooth can be finished without delay, as treatment of the canal can be resorted to by drilling through the platinum on the palatine surface, the opening being finally finished with amalgam, to match the metal, or with gold if preferred.

Porcelain Veneers.—For several reasons the use of thin porcelain veneers made especially for the work is recommended. They require little change of form, and the shading is more accurate and less liable to change than in a tooth ground for the purpose. As they are inexpensive a considerable number can be kept in stock, which is a convenience and also a saving of time. Plate teeth are frequently employed, and a few contend that there is no disadvantage in their use, and that is true so far as the porcelain is concerned. The disadvantage is that the porcelain tooth must be ground thin and every particle of the pin

must be ground away, otherwise there may be a check in baking. Now if the shade is correct before grinding, how is it possible for it to be so afterward when the flat side or ground work of the tooth, which governs the shade, is taken away? To retain the shade the tooth must be ground equally on both sides; this reduces production of shade to guesswork. We all know that grinding is tedious, and if the work is placed in the hands of the laboratory student the chances are that the result will be unsatisfactory. A further consideration is the fact that in using teeth the various products of different manufacturers act differently in re-fusing. This matters little if the face of the tooth is left intact, but if it is ground and given sufficient heat for re-glazing the result sometimes is different. There is also the further fact that some teeth require so much greater heat to re-gloss than the uniting body requires for correct fusing that the latter has lost much power of attachment in the process. I therefore recommend the use of veneers made for the purpose. They are of all sizes and shades and are arranged in twos, fours or sixes with the addition of bicuspids.

CHAPTER X

THE SHOULDERLESS COPING; THE PORCELAIN JACKET CROWN WITH PERFORATED PLATINUM BASE

Tooth Preparation.—The preparation is quite similar to that for a full gold crown. The walls should be tapered towards the occlusal, but the occlusal or cutting surfaces should be relieved more, at least one-thirty-second of an inch, to allow for thickness of platinum and porcelain at these points. Fit two copper bands: with one of these take a modelling compound impression of the prepared tooth.

Fig. 60.—The Shoulderless coping. Preparation.

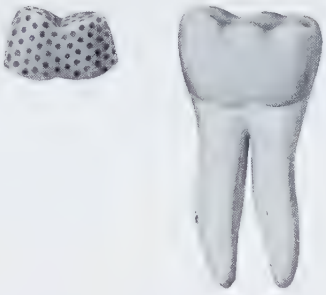


Fig. 61.—Platinum shell, fitted and perforated for porcelain attachment.

With the other, fill with wax, press to place over tooth, and take a plaster impression of the adjoining teeth over it. Take wax bite, prepare amalgam model of tooth, place die in wax impression, pour model, and pour the bite. These steps have already been described in detail. Remove die from model, and over it swage a seamless 30 gauge platinum shell. (For small teeth, a thinner gauge may be employed.) Trim this platinum for fit at the gin-

gival approximately, and try the shell in the mouth for perfect adaptation and gingival length.

With a good metal drill, perforate the entire surface of the platinum as shown in Fig. 61. With a small Miller stone, remove any protruding platinum about the holes on the inside. Replace the shell on the die, or try again in the mouth. Keep holes of shell one-half millimeter from gingival. The porcelain is built on this platinum base in the same manner as to the foil matrix for full shoulder coping restorations. Care must be taken, however, after the first and second fusings, to remove any porcelain which may have possibly leaked through into the inside of the shell.

If this type of crown is to be used as a bridge abutment, no holes should be cut into the platinum at the point where dummies are to be attached by soldering. This space is also left free of porcelain when building onto the platinum base. If interproximal rest is desired, it should be soldered to the platinum shell before porcelain building is commenced.

The Platinum Base Porcelain Jacket Crown as a Bridge Abutment

Advantages.—This type of porcelain restoration has a far larger application as a bridge abutment than the all-porcelain jacket crown. It is stronger to carry dummies, due to its base of platinum plate, and additions of dummies may be made by soldering either before or after the process of porcelain building: the platinum base may be kept free from porcelain at any desired spot, and extensions for fixed or removable bridges may be soldered on, made of platinum base, and the porcelain built on over its base and the attachment.

The author does not believe in soldering two or more of these platinum base crowns together with platinum wires

or bars and bake to these bars a number of porcelain dummies. This kind of porcelain bridge is not strong and proves unsatisfactory in most cases to the porcelain worker and patient. The difference in the expansion and contraction of such large portions of platinum bars (reinforcements) and the bulk of porcelain is so great that but very little union or strength exists. It is far more practical to fit and solder to these platinum bars gold boxes or backings and cement the porcelain dummies into same.

CHAPTER XI

THE PORCELAIN INLAY

Broadly speaking, one might say that there are two great divisions in porcelain work, as a restoration of tooth substance: the jacket crown and its modifications, and the porcelain inlay and its modifications. In the case of the jacket crown, the author has found it possible to outline a very definite technic throughout its entire course, because it is a restoration, the fundamental principles of whose application are always the same. In the case of the porcelain inlay, barring of course the elements of its wise selection, the operator has for his basis all the rules of cavity preparation, which have been widely studied and much printed.

The reader will do well to study the table of classification on page 14. Class II, subdivisions A and B, will include practically every form of porcelain inlay possible. Subdivision C, while still within the scope of inlay restorations, employs different principles, and therefore merits separate and distinct consideration. For these reasons, therefore, the author is contending himself with laying down certain basic rules for the construction of porcelain inlay restorations, drawn largely from the careful work done on this subject by Dr. Van Woert, and the reader is left to apply these principles in the several instances where he will find porcelain inlays to be desirable and successful. Operative technic in cavity preparation for the porcelain inlay must be largely a matter of individual choice: basic rules are always the same. With the classification in mind, and a thorough mastery of the principles, the student should be able to decide upon his own application.

A study of the following features in porcelain inlay construction will be of material aid:

1. For all restorations requiring preparation of approximal surfaces secure plenty of separation; the method outlined in this chapter has proved successful.

2. With a view to good anchorage and to easy withdrawal of the matrix material, cavity margins should be generously extended, following customary rules of extension for prevention.

3. Fill deep undercuts, and other deep portions of cavity; their reproduction in porcelain, if possible, would add nothing to strength and appearance of finished restoration.

4. Use abundance of $\frac{1}{1000}$ inch foil for matrix forming.

5. Burnish matrix material to deepest portion of cavity first.

6. With large inlays, fill deep depressions with porcelain, biscuit, then re-swage on model, or place matrix on tooth in the mouth and re-burnish.

7. Attempt in the first firing, to reproduce the dentine.

8. Invest matrix for baking in 2 and 3 wall cavities, and in flush joint and step preparations.

9. Divide the porcelain with small cross cuts, to prevent shrinkage away from the walls (for the first bake.)

10. Keep cavity margins clean and free from porcelain until final fusing. Absolute cleanliness in everything concerning the work is essential. One speck of dirt in the finished inlay may spoil it entirely.

Cavity Preparation

The author is indebted at this point to several well known authorities on porcelain inlays; to Drs. Van Woert, Ottolengui and Nyman he expresses particular indebtedness.

The problem of porcelain shrinkage has never been overcome: the problem of compensation for this shrinkage and for the thickness of the platinum matrix has been worked out with a quite marked degree of success. Resulting from the deficiencies in final fit of the inlay has come the question of the cement line and its elimination. The following

paragraph is a quotation from Dr. Ottolengui in the *Items of Interest*, January, 1904:

"It is possible to so arrange a cavity that, while at all other parts the cementing medium surrounding the inlay may occupy at least as much or even more space than did the matrix; along the margins, the joint may be made so close that the space will be considerably less than the thickness of the matrix material, and in some cases may even be brought into actual contact."

The application of this principle may be illustrated in the following diagrams (this material condensed from Dr. Ottolengui's article):

1. A cavity with exactly parallel walls and a flat seat would be impossible as a basis for a porcelain inlay, grant-

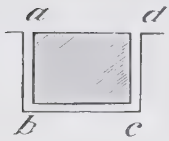


Fig. 62.

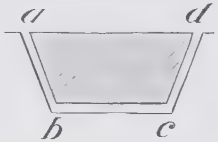


Fig. 63.

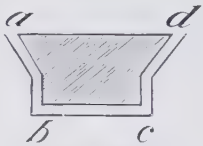


Fig. 64.

Fig. 62.—Box cavity. Walls at right angles to seat.

Fig. 63.—Four wall cavity. Walls at 45 degree flare from seat.

Fig. 64.—Four wall cavity. Walls from seat of cavity at right angles; walls to half the depth of cavity have flare of 45 degrees.

ing even that a perfect matrix could be secured. A glance at the figure will show that there could be no compensation for the thickness of the matrix, even if a block of porcelain could be fused which would accurately be seated in such a space. This type of cavity would obviously have the greatest strength from a retention standpoint, but would contain the greatest amount of cement once the inlay was in place.

2. The second form of cavity with walls flaring at an angle of approximately 45 degrees from the horizontal would naturally secure a much more perfect adaptation of the inlay to the walls, allowing for settling of the wedge

into place, but would not have great retention, the cementing medium furnishing its greatest retaining strength.

3. Type No. 3 is a compromise between 1 and 2. The flaring wall is prepared only to the depth of one-half the cavity. Grinding from the bottom of the inlay would permit perfect settling into position, and sufficient retentive strength would be given to make the inlay a success.

These are obviously only generalities; universal application would be impossible, but they furnish a basis for thought and for use, the student remembering that the closer to the right angled wall he can obtain with success the greater strength the restoration will have in the mouth.

With this principle in mind, the following general rules may be laid down in cavity preparation for the porcelain inlay:

1. Preparation to allow easy withdrawal of matrix or impression material.

2. Compensation for thickness of matrix material after its removal from the inlay. (This point has been explained, using Dr. Ottolengui's information as a basis.)

3. Abundance of separation for approximal preparations.

4. All margins as near right angles as possible. Porcelain cannot be fused accurately to a feather edge for strength: the principle of the "butt-joint" should be adhered to.

5. Compound preparations should be made if possible to permit a dove-tail to increase retention, but sharp angles, and small steps near cavity margins should be avoided.

Separation.—Older methods of tooth separation have almost entirely been replaced by ligature silk, because of its obvious advantages of being inconspicuous and of maintaining proper position. The technic for its application is quoted from Dr. Van Woert, as follows:

"Cut a piece of ligature silk of suitable size, about ten or twelve inches long (Nos. 5 and 6 being most useful for separating). Double the silk and pass through the loop a

piece of waxed floss of about the same length to act as a leader (Fig. 65, *A*). This is passed between the teeth to be separated and the ligature silk drawn through below the contact points and above the gum septum by the wax floss leader (Fig. 65, *B*) and a loop and knot made as shown in Fig. 65, *C* and *D*."

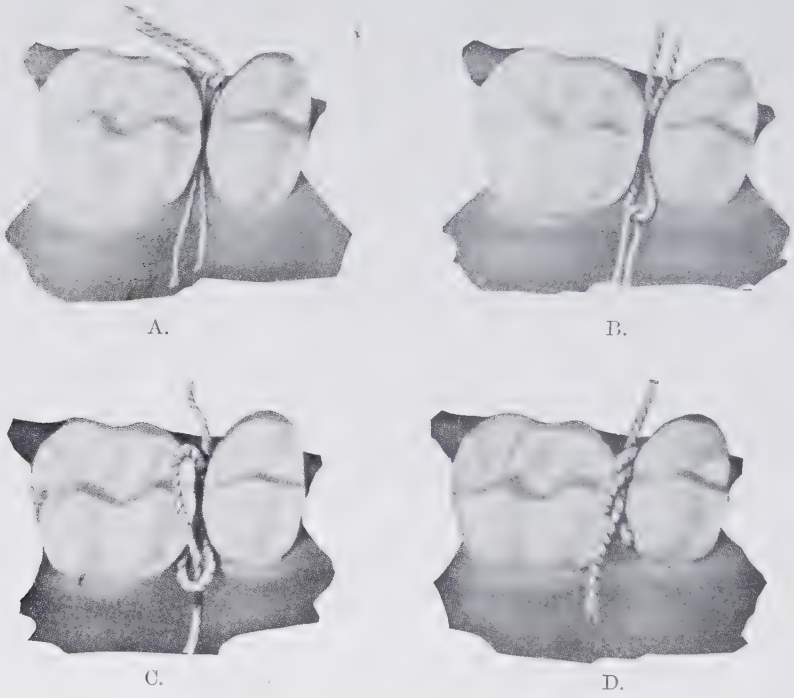


Fig. 65.—Progressive steps in separation with ligature silk.

It has been the attempt of the author to present material in this book which may be used to advantage and with success by the average dental practitioner. It is the exceptional man who can work direct in the mouth for the formation of any complicated platinum matrix, and granting exceptional manipulative ability the chances of success by the direct method in difficult cases form an average which is unfavorable to say the least.

This book on dental porcelains has been conceived in the knowledge that its principles, thoughtfully applied and practiced, would bring success to the average operator. The author believes that the direct method for the construction of porcelain restorations is not practical for the average man, except in the case of simple and easily accessible four wall cavities. Accurate impression technic has been outlined for the indirect method of procedure. The author believes it far better for the student of this work to master the indirect technic first, and then, if his skill in manipulation is sufficient, he may attempt the more complicated and certainly more discouraging matrix forming in the mouth if he so desires.

In the case of inlay restorations, a definite technic is outlined by the direct method, which may be successfully carried out for simple cavities; the main emphasis, however, is placed upon the indirect method.

Matrix Forming

Direct Method.—Use the rubber dam when possible; complete dryness is very desirable. Select $\frac{1}{1000}$ inch foil of suitable size, and between it and the cavity place a thin

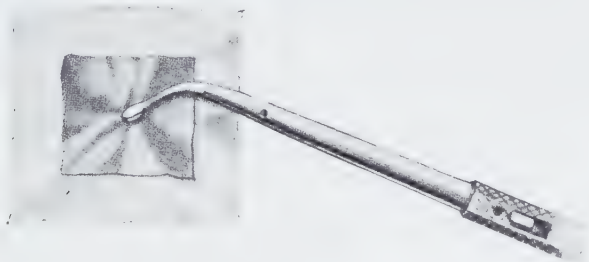


Fig. 66.—Matrix foil on China silk, held by foil carriers.

piece of China silk (Fig. 66), holding in position with foil carriers. Using small pieces of spunk or wet cotton, forced into the cavity, adapt foil to deepest portion of cavity as well as possible. Remove the foil, and separate from silk:

replace matrix, and with a small piece of unvulcanized rubber force into cavity, and when firmly placed there, burnish margins to close adaptation with cavity walls, securing their position with sticky wax. The rubber is now removed, the matrix being left in place. If further adaptation is necessary, it may be done at this time, using proper burnishers. (Fig. 67.) The student will remember that best results are obtained with as little direct burnishing as possible. Depend mostly upon swaging process furnished when the unvulcanized rubber is forced into the cavity. The matrix being examined and found perfect, it is now removed from the cavity, either directly with pliers,

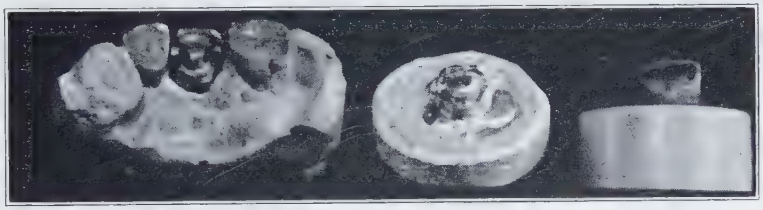
Fig. 67.—An assortment of glass burnishers.

if easy removal is possible, or by withdrawing it with a warm lump of sticky wax, and then burning the matrix free from the wax. The matrix is now ready for investment, any good investment used by the porcelain worker being satisfactory. By the direct method, the process of porcelain building is carried out complete from this point.

Indirect Method. -The impression has been taken as outlined, and the amalgam model has been made in the usual manner. Matrix material of suitable size is laid over the cavity, and with burnishers and spunk is adapted to the deepest portions first, leaving the edges and the excess beyond the edges free. When fairly close adaptation to

A. B. C. D.

Fig. 68.—Matrix forming. Indirect method.
A. Swaging ring filled with compound.
B. Amalgam model mounted in compound.
C. Matrix roughly adapted and burnished.
D. Matrix swaged and ready for trimming.



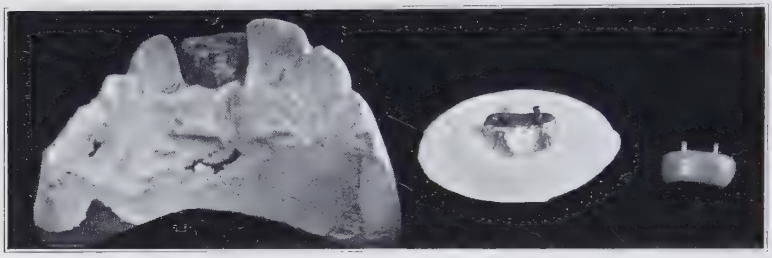
A. B. C.

Fig. 69.—The porcelain inlay. Indirect method.
A. Amalgam die in position on model.
B. Matrix invested, ready for porcelain.
C. The finished inlay.

Fig. 70.—Amalgam models showing root shaping and tooth preparation.

the deeper portions has been accomplished, the model is placed in the swager and further adaptation secured. When the desired result has been obtained, the process of porcelain building may be commenced. After the first fusing, the matrix with its biscuited porcelain may be re-swaged for closer adaptation at the cavity margins. The process, as in all indirect methods, is carried out on the model. (See Figs. 68, 69 and 70.)

Combination Method.—Where the operator feels some doubt concerning the ultimate fit of the inlay restoration, and additional visits by the patient are possible, the process may be carried out through the first firing of porcelain by the indirect method as outlined; the matrix is then



A. B. C.

Fig. 71.—Preparation showing double pin anchorage.
A. Die on model.
B. Matrix invested.
C. Finished inlay. Porcelain fused about pins.

placed in the cavity in the mouth, and the re-burnishing process is carried out by the direct method.

Any of several combinations of methods may be employed for this work. Many operators working by the direct method will complete the restoration from the original matrix after its first investment. In certain cases, the matrix is removed from the investment after the first firing and adjusted to fit in the mouth. Sometimes, with the indirect method, the inlay is completed with the exception of the final glazing, and then tried in the mouth for

final adjustment of occlusion, contact and fit. The author has suggested the three methods usually employed. Depending on the skill of the operator, combined with the element of good fortune in some of this porcelain work, any one of these methods, or all three, or combinations may have to be employed. It is again an illustration of the futility of outlining any operative or laboratory technic which the individual man will wish to use without his own modifications and improvements.

Bite Relations; Laboratory Technic.—When working by the indirect method, occlusal relations should be obtained in the manner already described for the all porcelain jacket crown. Amalgam models are prepared as already directed from the compound impressions of the preparations, and articulated models are made. (Fig. 71.)

Impressions.—Following Dr. Van Woert's practice, which has given the author much good inspiration with resulting success, the most suitable tray metal for individual trays for impression work is platinoid, obtainable in gauges 32, 34 and 36: this metal does not tarnish readily, is quite pliable, together with an ample resistance to pressure, desirable in any tray metal. The author prefers the Kerr impression compound, although any good composition with which the operator has had uniform results would be quite satisfactory. These trays with a slight practice may be readily made to meet the individual case, so that pressure during the impression taking may be directed practically at right angles to the cavity margins. As shown in the illustrations, the platinoid strips may be cut to suitable lengths and shapes, holes made with a plate punch to furnish retention for the compound, and easily adapted to the required space.

Employment of the individual impression tray for inlay restoration is subject to so much variation by the individual operator that descriptions fitting to every case are quite impossible. Several typical instances are illustrated and de-

scribed in this chapter: further development and use will readily come to the operator, who will do well to remember the simple rule of fashioning the trays so that pressure exerted by them will come as nearly as possible at right angles to the preparation.

The impression tray (see Fig. 72), with the accompanying technic is applicable for all cavities on labial, buccal, or lingual surfaces, where decay has not extended below the gum margin. Where caries has thus extended, the tray should be lengthened to go under this free margin. Ex-

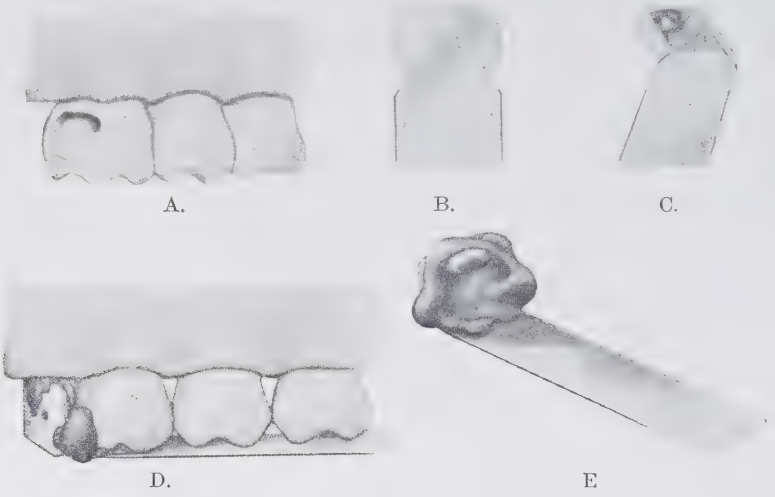


Fig. 72.—The Van Woert impression technic for labial, buccal or lingual cavities.

treme convexity should be met by contouring the surface of the finished tray. Mesial or distal extensions of a cavity of this type are cared for by proportionate extensions of the respective tray surface, and by further contour at the desired spots.

For impressions of simple approximal cavities, either labial or lingual, the tray is shaped as in Fig. 73, *B*. The fold in the tray metal is made to allow very little surplus over the cavity margins; compound is attached, and the

impression mass placed in the cavity, and pressure at right angles to the cavity is obtained with a small thin instrument, as in Fig. 73 *D*. Upon cooling, and before removal, excess which would interfere with easy withdrawal is cut away.

Cavities as represented in Fig. 74, involving both lingual and labial of an approximal surface are practically impossible by the direct method, and an impression by the indirect method requires some study and practice. Fig. 74, *C, D, E,* shows the shaping of the compound tray: the sliding section should be so fitted that there will be little lost motion laterally, while allowing easy movement along its long axis. (Fig. 74, *E*.) The impression is taken by introducing the compound lingually on the first section, with the spatula in the hands of an assistant, held so as not to interfere with the movement of the second section. Surplus compound is removed and carved to the contour of the labial surface flush with the cavity margin, as shown in Fig. 74, *G*. Vaseline the surface of tooth and compound on the labial, and using a minimum amount of compound, slide the second section to place, exerting even pressure. This is cooled, and removed; then the spatula is removed, lastly the first section. The two sections are now united with sticky wax.

Fig. 75, *A, B* and *C,* shows the treatment of disto-occlusal cavities in molars. Fig. 76, *A* and *B,* shows similar treatment for mesio-occlusal cavities. Fig. 77, *A, B* and *C,* and Fig. 79, *A* and *B,* shows treatment of cavities where caries has extended beyond the usual occlusal outlines, where further extension of the tray material is necessary. Fig. 78, *A, B, C* and *D,* illustrates one method for impressions of compound cavities in molars and bicuspids: the two sections are united with soft solder and should be thoroughly adapted and burnished to the tooth before compound is added for impression taking.

Where extreme extension of caries over the occlusal sur-

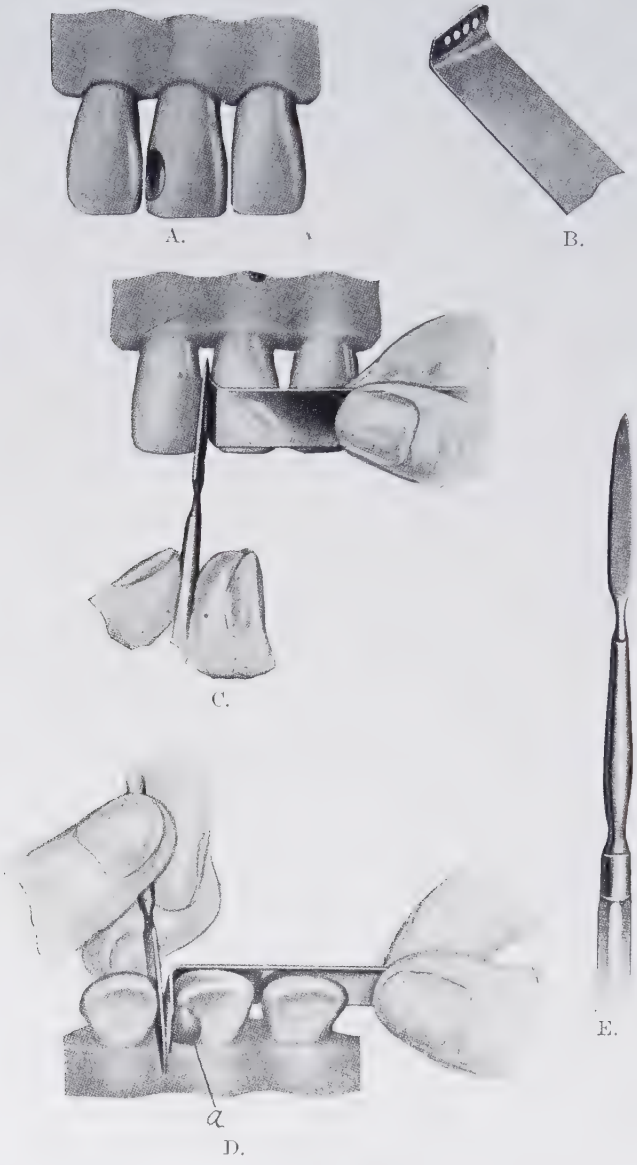
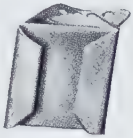


Fig. 73.—The Van Woert impression technic for simple approximal cavities.

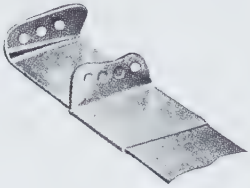
A.

B.

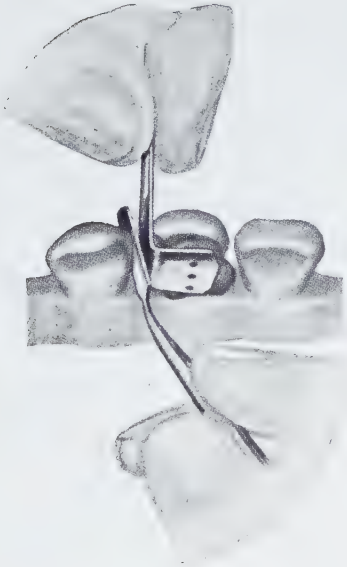
C.



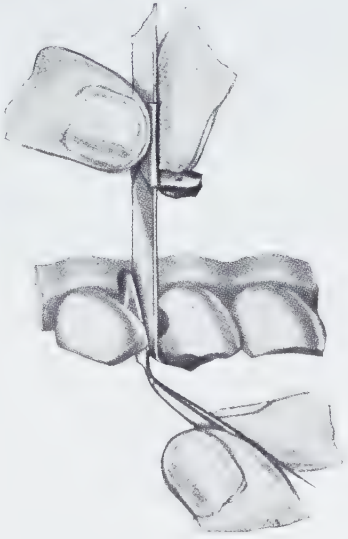
D.



E.



F.



G.

Fig. 74.—The Van Woert sectional compound technic for large approximal cavities.

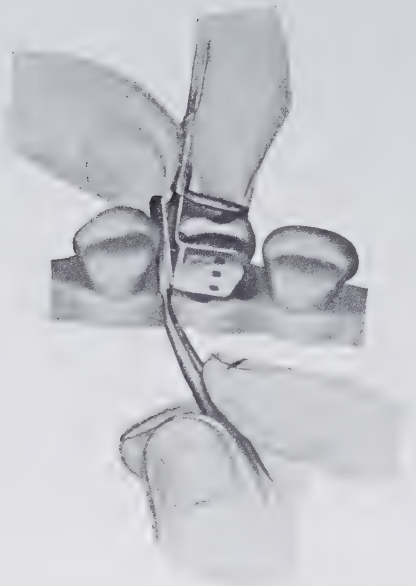


Fig. 74-H.

A. B. C.

Fig. 75.—The Van Woert impression technic for disto-occlusal cavities in molars.

A. B.

Fig. 76.—Treatment of impression tray for mesio-occlusal cavities in molars.

face has not taken place a tray fashioned as in Fig. 79, *A*, *B*, *C* and *D*, will be satisfactory: this tray is made in one piece, and should be burnished to approximate fit before impressions are taken.

To quote Dr. Van Woert: "The possibilities with trays of this character are limited only by the ingenuity of the operator, and with a little thought and effort results will

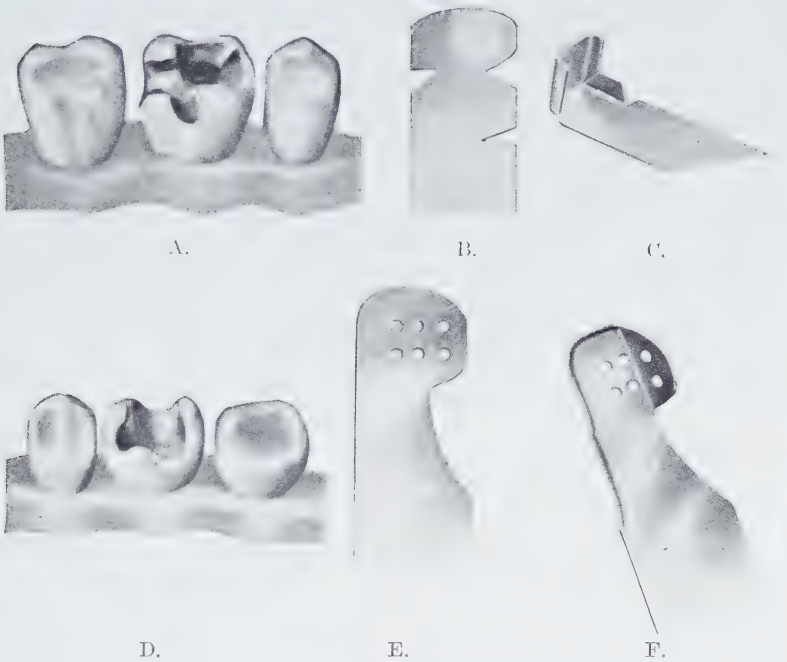


Fig. 77.—Tray extensions to care for impressions of preparations where caries extends beyond the occlusal surfaces.

be obtained which, to the inexperienced, might seem almost impossible. Contours of the centrals, laterals and cuspids require trays of a definite shape and varied in proportion to the extent of the restoration. That portion of the tray which covers the buccal and lingual wall should conform closely to the shape and should extend beyond the margins of the cavity only enough to insure a right angled pressure

A.

B. C. D.

Fig. 78.—Van Woert impression technic for MOD cavities in bicuspids and molars.

A.

B. C.

D.

Fig. 79.—MOD impression tray to allow for extension over occlusal surfaces.

against the same. A tray for one case rarely proves available for another, because of two conditions: the buccal and lingual wing of the tray is apt to be too great for one case and not enough for others. In one case the right angle pressure is lost, while in another it becomes difficult to withdraw the impression, sometimes positively preventing it. Hence it is a saving of time and energy (and as time is money, it is a saving of money) to make a new tray for each case."

Impression Taking; the Band Method.—The author makes continual use of the method of impression taking just described. For accurate reproductions of approximal and four wall cavities it has no equal. For impressions of cavities involving not only the approximal surfaces, but also the coronal of bicuspids and molars, the band impression described under the all porcelain jacket crown will give excellent results. For this type of work, depending upon the operator's preference, the copper band may either be filled with compound and pressed to place, or it may be adjusted over the tooth, and the area desired taken by pressing the compound into place through the band. Some experience, together with the resulting good judgment will aid in determining the proper method for the individual case.

Thirty-six gauge copper bands may be trimmed and fitted over the tooth in such a manner as to expose and inclose the prepared cavity perfectly, not allowing the band to go beyond the point of greatest contact. The Kerr compound may then be forced into the cavity and the band, filling it completely, chilled and withdrawn without distortion.

Porcelain Building.—The following paragraph is quoted direct from Dr. Van Woert:

"The fusing of porcelain in unprotected or uninvested matrices I consider a great mistake, as the shrinkage of the porcelain is sure to distort or pull the matrix out of shape. The extent of the distortion will depend upon how the fus-

ing is done; that is to say, at what temperature. It is a fact that all high or low-fusing porcelains will fuse at a very much lower temperature than they are rated at by the manufacturers, the difference being in the amount of time required to accomplish the result. It is also a fact that any of the porcelain now upon the market will yield a very much more perfect result when fused at the lowest possible temperature. First, it has more strength; second, a better translucency; third, it may be ground and polished without danger of etching after its insertion; fourth, its

Fig. 80.—Mound formation of porcelain, keeping clear from matrix walls.

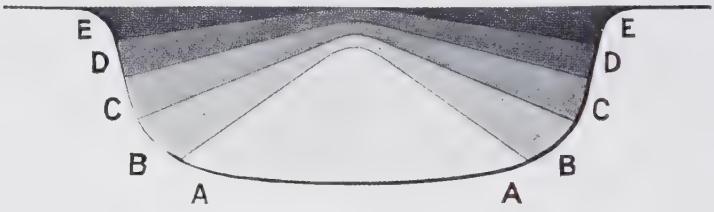


Fig. 81.—Successive steps in porcelain building for inlays.

color is permanent and makes possible a selection for a given case with little difficulty; and when blending of two or more colors is required this is limited only by the ability of the individual operator; fifth, the only change in shape of an inlay is the shrinkage characteristic of each material and when a method of construction is employed which reduces the shrinkage to a minimum at the margin the change is hardly perceptible."

Following this line of reasoning: after the matrix has been secured it should be invested in any good porcelain

investment, such as Pelton's No. 2. A small platinum tray, easily made from No. 30 gauge platinum is a good carrier for the invested matrix.

The process of porcelain building is comparatively simple. Porcelain should be added in creamy consistency at the deepest portions of the cavity first. Successive layers are added and biscuited, keeping away from the margins of the cavity, and more or less forming a mound or pyramid of porcelain, whose apex is in the center of the cavity. The final layer should be fused to a glaze. The accompanying figures (Figs. 80 and 81, reproduced from Dr. Van Woert's article), illustrate the successive steps.

Retention; Cementation.—The inlay has been fused, and the platinum matrix has been removed. Retention pits for cement may be cut with fine carborundum stones, or with diamond drills. The inlay is cleaned from grit with kerosene and a piece of cotton. It is then settled into a warm piece of wax, and all surfaces save that which will attach to the cement are carefully protected with wax. A little hydrofluoric acid is then wiped over the surface left free and allowed to remain for about five minutes; the inlay is then neutralized with bicarbonate of soda, and removed from the wax. Necessary adjustments are made in the mouth and the inlay is ready for cementation.

The choice of a certain cement, there being several good products, is largely preference. It should be finely ground, and the operator should possess a sufficient number of shades to blend as closely as possible with the color of the porcelain. The cavity is dried and sterilized, and the cement is mixed thin, and the cavity is filled full. The inlay should be settled gently to place, using very little pressure: it should, however, be held under pressure until the preliminary setting of the cement has taken place. After five minutes excess cement should be removed, and the patient dismissed until a subsequent sitting for any further finishing which may be necessary.

CHAPTER XII

THE PARTIAL COPING
OR
THE ALL PORCELAIN THREE-QUARTER VENEER CROWN

There are certain types of cases where the full jacket crown may not be deemed indicated. There are many vital teeth, where caries has destroyed both approximal surfaces, extending well into the palatal, leaving the cervical two-thirds practically untouched. To construct a full jacket crown for such a case would be to destroy the only unbroken enamel remaining. This condition is noticeable largely in upper centrals and laterals: indeed, the restoration herein described is limited mostly to the six upper anterior teeth. Large porcelain inlays, involving both incisal angles are extremely difficult of construction, and the resulting narrow strip of incisal enamel is apt to be too much weakened to be retained without fracture. Consequently, the all porcelain three-quarter veneer crown has a definite practical field among the type of cases which have been briefly outlined.

When employed as indicated, this type of porcelain restoration presents two noteworthy advantages which may indirectly have a bearing on other points of merit in its wise selection. First, a restoration of this type has an unbroken cutting edge, with the joint between the porcelain and the labial enamel a straight line parallel with the incisal edge, a factor instrumental in producing proper light refraction, and an apparent obliteration of the joint. Second, where, as described, it is deemed wise to save the la-

bial enamel, this restoration may be made with a comparatively small destruction of vital tooth tissue.

Tooth Preparation.—The reduction of the labial third of the tooth depends on two conditions: first, opposing bite, and second, the labial contour. Obviously the cardinal requirement for this reduction is for purposes of strength. Cases with wide unopposed overbite require very little reduction of the cutting edge. A long overbite, combined with a narrow overjet demands a reduction sufficient to satisfy some rather extreme demands upon the restoration. The second condition comes into the realm of esthetics. If the labial surfaces of porcelain and natural enamel can be placed very closely in the same plane, the refraction of light will tend to obliterate the joint.

The mesial and distal cuts are tapered as in a full veneer preparation, leaving a narrow shoulder. Depending on respective immunity to caries, or on the relative shape and size of the teeth, this shoulder may, at discretion, be extended beneath the free margin of the gum.

The palatal surface of the tooth is reduced to allow at least a twenty-four gauge space between the preparation and the opposing tooth or teeth; the shoulder at mesial and distal is now extended around the palatal extremity of the preparation.

It is assumed that the reader is already familiar with the technic for the all porcelain jacket crown. A review of its preparation will serve to make more clear many points which are touched upon only briefly in this description. The copper band, modelling compound impression of the preparation, the wax bite, amalgam model, and subsequent articulation are carried out as outlined under the technic for the all porcelain jacket crown. The first departure from the customary procedure comes in the adaptation of the platinum foil matrix.

Matrix Making.—The amalgam model is imbedded, labial surface down, in Kerr compound, into the lower half of the swager: the incisal edge of the preparation should be left free. The platinum foil, one one-thousandth inch in thickness, with generous excess, is adapted with finger pressure over the preparation.

It is then swaged into position. Then, leaving the foil still in place, cut a V-shaped slice from each corner at the incisal. Remove the die from the swager and fold the extending foil over the cutting edge and burnish carefully to

Fig. 82.

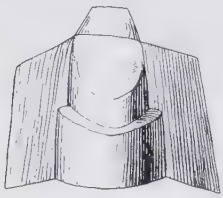


Fig. 83.

Fig. 84.

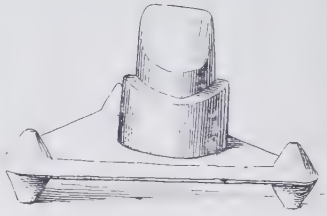


Fig. 85.

Fig. 82.—Amalgam model for three-quarter crown restoration. Lingual aspect.

Fig. 83.—Matrix forming for three-quarter crown.. Lingual aspect.

Fig. 84.—The finished matrix for three-quarter crown. Labial aspect.

Fig. 85.—Position of matrix on fire clay tray.

good adaptation. Bring the extending excess platinum, mesial and distal, over to the labial, overlapping the fold which has been made over the incisal. Using long nosed pliers make a Tinner's joint in the center of the labial surface and burnish the joint as smooth as possible. Remove the matrix from the amalgam model, and cut its extending apron to allow its upright position on the fire clay tray. Replace the die in the compound for final burnishing and swaging.

Porcelain Building.—Viewed from the labial, the porcelain three-quarter veneer crown is restoring only enamel: it is enamel in such a position that it would normally not be influenced by the underlying basic color of the dentine. Consequently the porcelain must be built from the start in two shades; the enamel shade for the incisal, mesial, and distal, and the basic color for the palatal surface. Depending on the extent of restoration of mesial and distal surfaces, some color blending may be found necessary towards the cervical.

Fig. 86.—The finished restoration; three-quarter crown. A, Labial view; B, Palatal view.

The matrix need not be invested for fusing, but should rest upright on the fireclay tray. The crown may be tried in the mouth for length and color without removal of the matrix. Necessary adjustments may be added. Care should be taken not to build the porcelain too full at the labial joint, allowing the platinum at this point to prevent overlapping.

When complete and ready for insertion, the matrix should be carefully removed. Cementation is satisfactorily accomplished, using the right shade of silicate cement at

the labial, and crown and bridge cement for the remainder. Place both cements on the porcelain at the same time and insert in the tooth, using a firm gentle pressure to guide the crown to place. The author has found Smith's "Certified Enamel" to be a satisfactory silicate in this particular location.

CHAPTER XIII

PIN ANCHORED PORCELAIN INLAYS

It is often necessary to consider retention supplementary to retention form and frictional contact in the construction of porcelain inlays for anterior teeth. Such retention takes the form of a pin anchorage, which may be baked as an integral part of the inlay, or prepared to be cemented into suitable places prepared for it in the tooth and in the porcelain. The first method is called The Baked-in Pin, and the second method the Foil Tube method. Relative advantages of the two methods, whether for partial or complete tooth restorations are considered separately.

Impressions.—After the preparation has been made, select a suitable location for the pin anchorage, and a hole is drilled, running in the long axis of the tooth, to a depth compatible with the safety of the pulp, and with adequate strain or strength to be demanded of the anchorage. By "suitable location" is meant at such a place where a twenty gauge (or less) round platinized gold or platinum pin or wire may be safely inserted.

The size and length of the pin anchorage depends, as has been mentioned, upon the proper compromise between size of restoration, strength of occluding bite, lateral strain, and a proper regard for the subsequent vitality of the tooth, assuming that the tooth is alive.

It is common for beginners to employ too large a pin for corner or inlay restorations. It is customary to use an anchorage of twenty gauge or less. If more than one pin is used, care must be taken to make the two holes in the tooth parallel to each other: otherwise, the impression will drag upon removal, and difficulty will be encountered in

cementation of the finished product in the mouth. In cases demanding restoration of mesial or distal angles, where but a single pin is used, it is usually anchored near the cervical, running with the long axis of the tooth. Such an anchorage should be relatively thicker and of a stronger alloy than when the double anchorage is employed. Before taking the impression, the pins are inserted into the drilled holes in the tooth and allowed to project at least one-sixteenth inch. These pins should fit loosely to permit ready withdrawal with the compound impression.

The impression is taken with Kerr Compound, placed in a suitable small tray or copper band, which will surround the prepared tooth to the depth of the preparation. Leaving this impression in place, a small plaster impression is taken over it, including several adjoining teeth.

A wax bite, with No. 40 tinfoil between the two layers of wax is now taken.

The Kerr Compound impression in the plaster is now packed with amalgam and built up to a cone for retention in the plaster and for convenience in handling. When set, the amalgam and the plaster impression are varnished and the cast is made with plaster or with stone. It is always wise to protect the pins before using amalgam. This may be done with wax, either before placing them in the tooth, prior to taking the impression, or with wax or varnish just before packing the impression with amalgam. Place the wax bite on the model and pour the articulation.

Matrix Making: Porcelain Building.—Cut a hole in the base of the plaster model and push the amalgam die from its place. Using matrix foil, one one-thousandth inch in thickness, burnish and swage a matrix over the preparation, allowing a generous excess or apron beyond the edges.

Push the platinum pins through the foil to place in the amalgam model. Attach the pins to the matrix with sticky wax. Remove the matrix from the die and invest. When

the investment is hard, boil out the wax. The porcelain is built to the matrix in the usual manner; the first layer encloses the pins to allow their removal with the matrix: the final layers are added with the matrix in place on the amalgam model. The platinum foil is carefully removed before cementing by drawing the foil from the edges towards the pins.

The Foil Tube Method.—The procedure for the foil tube method is the same as for the Baked-in Pin method up to

Fig. 87.

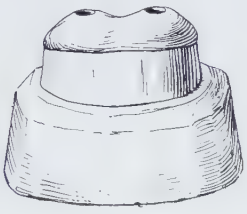


Fig. 88.

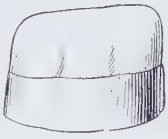


Fig. 89.

Fig. 90.

Fig. 87.—Amalgam model of butt joint inlay: matrix and tubes in place.
Fig. 88.—Matrix and tubes invested preparatory to first bake.
Fig. 89.—Finished inlay: matrix not removed.
Fig. 90.—Finished inlay in place on model.

the placing of the pins in the metal die with the foil matrix in place.

Instead of using platinum pins, small foil tubes are rolled to the size of the pins and pushed to place through the matrix into the holes in the metal die. The tube should extend to the desired depth in the restoration. Fix the relation of the tube to the matrix with sticky wax, leaving the tube open at both ends. Remove matrix and tubes from the die and invest, filling the tubes with investment ma-

terial. Boil out the wax, and build porcelain onto matrix enclosing and covering the tube. Bake to biscuit, wash off investment, replace matrix on model and finish the porcelain building to desired length and contour.

The Problem of Pin Anchorage for Porcelain Restorations

The question of adequate anchorage for individual porcelain restorations has served as a drawback from its wise employment in the mouth. Simple jacket or coping restorations make retention a simple matter, providing that certain elementary requirements are first complied with. Smaller restorations, which require more detailed provisions for safe anchorage have proved a veritable horror for the practitioner who has had the sad experience of seeing many faithful efforts fail within a short period after their insertion in the mouth.

Obviously the matter of the baked-in pin anchorage has been studied, too often, indeed, with discouraging results. The checking of the porcelain about the pins has hopelessly weakened many an otherwise perfect porcelain restoration, due to the variance in contraction between the metal and the porcelain under the stimulus of heat.

The author believes that the consideration of the porcelain and of the anchorage as two separate matters may possibly help to solve a very discouraging problem. The porcelain may be fused separate from the anchorage, without being weakened by the presence of a foreign substance, and the finished restoration may be cemented in the mouth, pin anchorage to the porcelain and to the tooth in the same operation.

Such a technic may be known as the Foil-Tube method and owes its success primarily to two important factors, which will become clear during its description. This method may be employed wherever it has been customary to use a baked-in platinum anchorage for any porcelain restoration.

Impressions and models are made in the usual manner: the pin or post anchorage is prepared for the individual case, either of iridioplatinum or platinized gold depending upon the amount of strength required. Using the pin or post as a guide to the size tube required, wrap matrix foil about it to form a tube. This tube is inserted through the

Fig. 91.—Special diamond drill for cutting anchorages into porcelain restorations.

hole in the matrix at the proper point, allowing sufficient extension into the porcelain to take care of proposed depth of anchorage at this point, and enough extension beyond the matrix to engage the investment material when the matrix is prepared for the first fusing. The first bake is made with the matrix and tube invested. Following this,

the investment is removed, and the final porcelain building is completed with the matrix and tube on the model.

The first advantage of such a method is as follows: The tube is not soldered, thereby leaving the edges free. The platinum is thus left free to expand and contract.

Its cooling and heating is coincident with the baking process, but, is not subject to the same limitations as the solid pin, which causes resultant checking and weakening of the porcelain. The matrix foil is removed with the engine bur prior to cementation, and the hole thus remaining will fit the pin anchorage originally prepared.

The second advantage of such a method is, for the most part theoretical. It concerns the problem of the action of cement under porcelain. Peculiarly enough, few porcelain restorations fail because of disintegration of the underlying cement. A theory which apparently has good clinical evidence back of it would seem to show that the slow thermal conductivity of porcelain tends to produce a permanency of its underlying cement. Porcelain jacket crowns have checked or broken, but seldom, if ever, have they failed in the mouth, due to the dissolution of the attaching cement. Hence the presentation of a cement anchorage in porcelain, as an attaching medium for a supporting pin or post would seem to have an abundance of favorable evidence to back it.

Clinically, at least, the Foil-Tube method has proven a great success. Its principle has been carried to the construction of rests, occlusal or interproximal, in the construction of porcelain bridges.

These rests are made in the porcelain with specially constructed diamond drills. It is expected that these drills will soon be available as part of the diamond drill equipment furnished by the S. S. White Company. Proper porcelain anchorage is secured, and the rest is cast in gold from a pattern adapted in the mouth: clinically this innovation has also been successful.

CHAPTER XIV

PORCELAIN RESTORATIONS WITHOUT USE OF ELECTRIC FURNACE

INCISAL TIP RESTORATIONS FROM STOCK TEETH WITH CEMENTED PIN ANCHORAGE

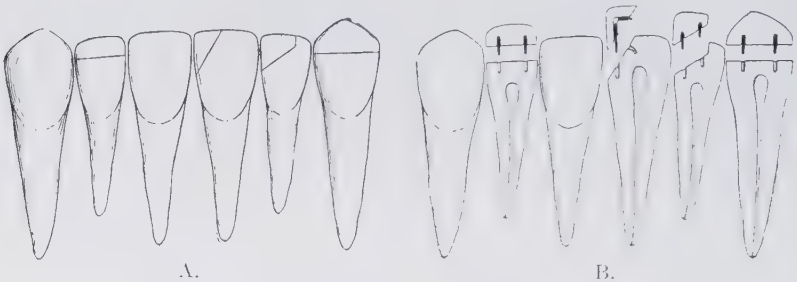
PIN ANCHORED BUTT JOINTS FOR INCISAL TIP RESTORATIONS

Frequent accidents to anterior teeth, both upper and lower, causing loss of incisal corners or edges, have given the dentist great trouble: restorations of such conditions were difficult, and ultimate success was doubtful. The majority of such cases are in the mouths of young persons, whose strenuous life has placed them under conditions where such accidents are common. Pulp chambers are nearly always large, making a restoration requiring much cutting inadvisable, and the extent of pulp injury in the case of accident is seldom easily determined. The method outlined in the following paragraphs is remarkably permanent, satisfactory as to aesthetics, and accomplished with a minimum of sacrifice of tooth tissue.

Fig. 92 pictures several typical forms of injured anterior teeth, cases with which every dentist has been confronted, repair and restoration of which injured areas he has many times been at a loss to plan.

Tooth Preparation.—Depending upon the direction and extent of the line of fracture, the operator may produce a simple butt joint, or a butt joint with step or angle. It is better, if advisable to produce a straight line. With a suitable thin carborundum stone the ragged line of fracture is smoothed to a straight line, so that the enamel

Fig. 92.—Diagram showing several typical traumatic injuries to the six anterior teeth.



A. B.

Fig. 93.—Incisal tip restorations showing pin anchorage locations. A, Completed case showing butt joints.

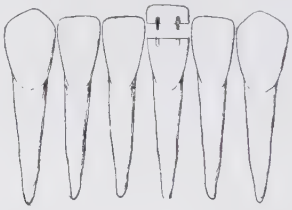


Fig. 94.—Lower incisor restoration showing pin anchorage location.

Fig. 95.—Corner restoration showing start of holes for pin anchorage.

margin through the entire outline of the cavity may be unbroken and strong. Fig. 93 illustrates the approximate location for the pin anchorage for the types of restorations demonstrated in Fig. 92. This location should always be made into dentin, but close to the enamel layer to prevent exposure of pulp. The exact point of entrance for the anchorage is made with No. ½ or No. 1 S.S.W. round bur, in a direction to follow the general lines shown in the several restorations in Figs. 93 and 94. A modelling composition impression is now taken, using a small copper band or tray; when thoroughly set, it is removed, excess trimmed, and then replaced on the tooth. A plaster or compound impression is now taken over the impression

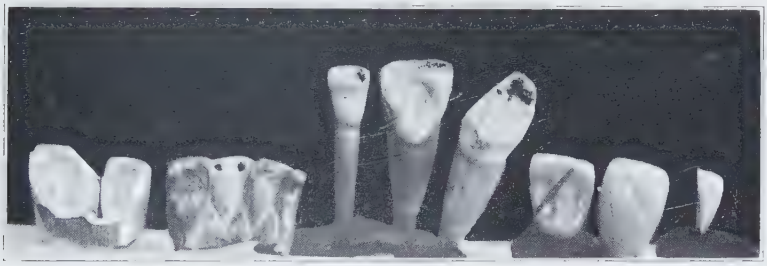


Fig. 96. Stock tip restorations.

material, including the directly adjoining teeth. Remove when set, and examine original impression for distortion and errors. The points of entrance for the pin anchorage should show definitely in the compound impression. Take a wax bite. Pack amalgam into impression of tooth to be restored, and make a plaster model over this. The model is separated, and the bite is poured.

Preparation of Stock Tooth.—Color has already been determined upon. Select any dowel crown of suitable size and shade, and with a (Fig. 97) knife-edged stone remove, *with some excess*, a portion corresponding to the area of the restoration, and as illustrated in Fig. 98, grind away *this excess* until this porcelain tip can be adapted perfectly

to the amalgam model of the preparation. Assuming correct size, shape and color, this should replace the missing portion perfectly. Should the thickness be too great, the tip may be reduced by grinding from the palatal surface, to retain finished glaze at the labial.

The Porcelain Anchorage.—Flow a little wax over the ground surface of the porcelain and press to place upon the amalgam model. Upon removal the wax will give an exact guide as to location for the holes for the pin anchorage.

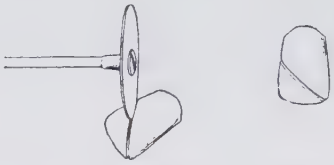


Fig. 97.—Preparation of porcelain tip from stock tooth.

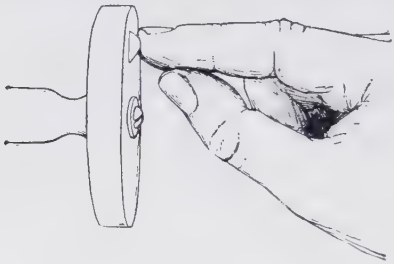


Fig. 98.—Removal of excess porcelain on engine stone.

The pins used for anchorage vary from 18 to 22 gauge platinum or platinized gold wire. A hole in the porcelain slightly larger is necessary. Use a diamond drill for this purpose. A lapidarist or stone cutter can usually be found in any city, and the operator may have the holes made in the porcelain by him. It is advisable to accomplish the drilling in the operator's laboratory, using a similar means to that employed outside by lapidarists.

Drilling the Holes.—Fig. 91 shows specially made diamond drills. Before these special drills were obtainable,

the author tried various methods of drilling, and the one following is the easiest and best that he has found. The drill is made from a piece of soft iron plate, fashioned into a tube of proper size, secured with binding wire, and mounted on the shank of a lathe or engine bur for the No. 7 handpiece. The material used for making tintypes is ideal for this. Oil and diamond dust are employed as the cutting agent. Fig. 99 shows the several steps in the formation of this drill which may be mounted in the engine lathe, or in the No. 7 handpiece.

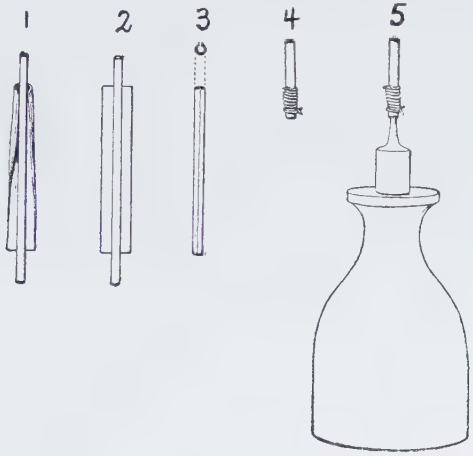
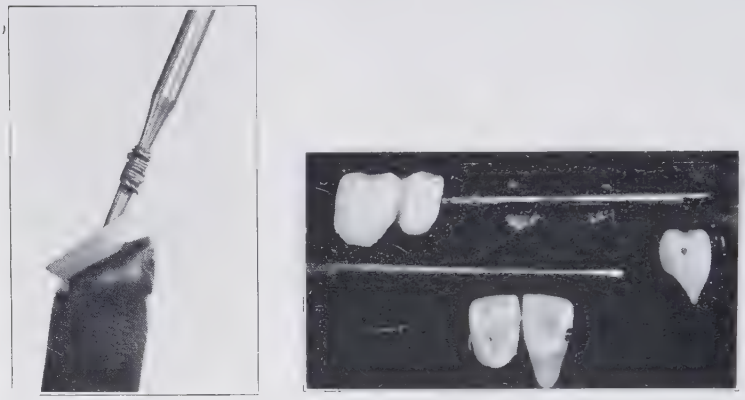


Fig. 99.—Pin anchorage drill formation.
1, 2. Steel shank of old engine bur wrapped with soft iron.
3. Diameter of tube. Inside measurements usually about 20 gauge.
4. Tube secured with fine wire.
5. Tube mounted on chuck for engine lathe.

With a little practice very minute holes may be made with this drill with perfect safety. Being a tube drill, it is necessary to break out the porcelain core several times during the process, to prevent clogging of the drill; slight pressure with a steel sewing needle against the side of the core will accomplish this. The diamond dust and oil will leave a black deposit during the course of the drill which must be removed with kerosene and a fine point (wooden

toothpick). For the beginner it is best to start the holes with a small carborundum stone or a fine diamond drill, and then in proceeding use very little pressure, as the diamond dust is a rapid cutting agent and does its work very quickly. Fig. 100 shows a convenient method of holding the porcelain during drilling, being simply a stick of modelling composition into which the porcelain tip has been set.

Position of the Holes.—In the restoration of incisal corners, it is obvious that the two holes in the porcelain tip will be made somewhere nearly at right angles to each



A. B.

Fig. 100.—Method of drilling holes in porcelain. A. Porcelain tip mounted in modelling compound. B. Tube or diamond drills for end support bridges. (See Fig. 91.)

other. In such instances, it is an excellent plan to join the two holes, for the following reason. When the tip is set, the vertical pin is cut to fit the entire length of the hole, both in the porcelain and in the dentin, while the horizontal pin is made slightly shorter than the length of both passages which have been cut for it. Soft cement is flowed into all hole anchorages, and the tip is set with especial care to place in position the vertical pin: the pressure of the cement around the corner in the minute free space will

force the horizontal pin into place and complete an automatic locking of the restoration. (Fig. 95.)

Completion of Restoration.—The holes have been completed, and the porcelain tip fitted, the anchorages in the tooth are finished to proper depth, the pins fitted and adjusted, and the restoration cemented to place with one mix of soft cement. Never try to bake the platinum pin into the drilled holes of these restorations. It weakens the porcelain. The cement anchorage is far stronger.

Application of This Type of Restoration.—Restoration of parts of natural teeth in the mouth is not the only means in which this method can be used. Broken porcelain corners on vulcanite, gold and continuous gum dentures and bridges may sometimes be repaired very satisfactorily in this manner. The diamond special drill or the tube drill would, of course, have to be used in the mouth for making anchorage in the broken porcelain. Otherwise, the general procedure would be the same.

When the restoration planned is similar to the one illustrated of the right lateral in Fig. 92, the impression is taken in the usual manner, but provision is made only for one vertical pin near the mesial surface. The stock tooth is cut as though it were to replace the entire corner, not considering the angle or step at all, the slanting surface from mesial to distal is obtained and then, grinding from the distal the angle form can be reproduced. For the beginner it is better to prepare two amalgam dies: the first is trimmed to eliminate the step entirely, and the stock tip is fitted to this surface in the manner already described. The tip is then fitted to the second complete model and the step accurately adapted.

Porcelain corners prepared from stock teeth have great edge strength and will not crumble at the joint as will the porcelain corners baked into a matrix. This is due to the fact that stock teeth are pressed or condensed into metal

molds, and are therefore denser in texture than the hand carved and prepared teeth.

The Use of Porcelain Inlay Rods (Fig. 102).—Remove decay from cavity, cut with a suitable fissure bur, or with a small Miller stone, the four walled cavity in the tooth perfectly round, and of sufficient depth. Finish walls with fine tapered Miller fissure stone, select in inlay rod of suitable color, reduce and taper the end of the rod to fit the

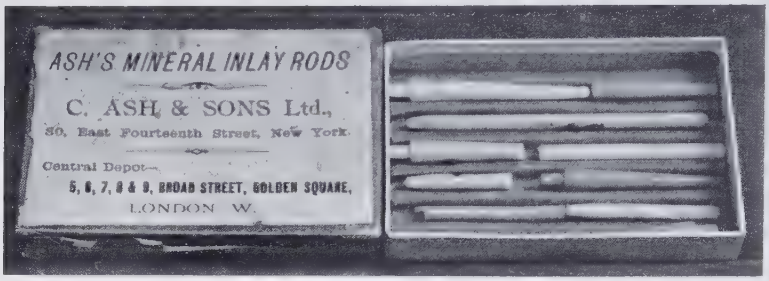

ASH'S MINERAL INLAY RODS
C. ASH & SONS Ltd.,
80, East Fourteenth Street, New York
Central Depot—
5, 6, 7, 8 & 9, BROAD STREET, GOLDEN SQUARE,
LONDON W.

Fig. 101.—Ash's mineral inlay rods for round inlay restorations.

Fig. 102.—Cavity formation and fitting with inlay rods.

cavity. This fitting of the rod may be done outside of the mouth on a tooth brush handle, by drilling a hole of the same size as that of the cavity, into the tooth brush handle. After fitting the rod cut a groove just above the depth of the fitted rod end, this will allow easy handling when cementing rod end into cavity, and permit breaking off the rod after cementing into place. The extending broken end is then stoned and polished in place after cement has set.

CHAPTER XV

THE REMODELLING AND STAINING OF STOCK TEETH AND FACINGS FOR USE IN CROWN AND BRIDGE WORK

Application.—That a great number of manufactured artificial crowns and facings are unsatisfactory both as to shape and shade cannot be questioned. That such products are sold would seem to indicate that their imperfections are accepted by their users. It must, however, be admitted that a perfectly aesthetic restoration of a given case is seldom achieved with the aid of unaltered stock porcelain

A. B.

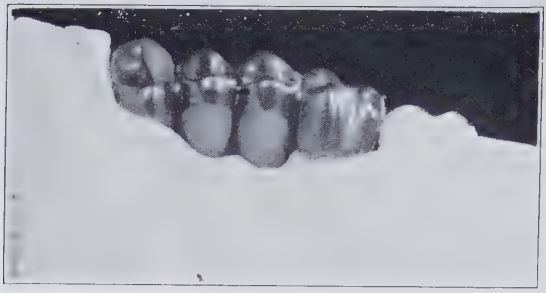
Fig. 103. Fig. 104.

Fig. 103.—The adaptation of pin facings for bridge pontics.
A, Long blunt pin facing bevelled and fitted before addition of porcelain for root tip.
B, Facing with root tip of porcelain added.

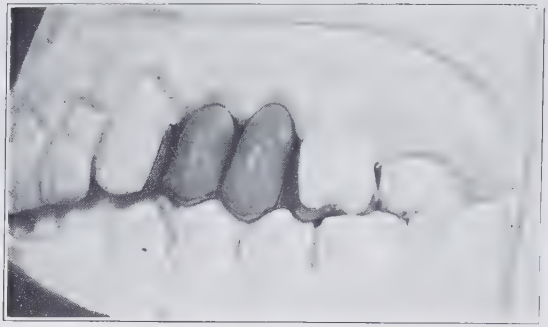
Fig. 104.—Wax patterns for castings to fit prepared facings in Fig. 103.

A. B.

Fig. 105.—Bridge supplying upper bicuspids using long pin facings with root tips added. A, Buccal view; B, Lingual view.



A.



B.

Fig. 106.—Step construction of bridge shown in Fig. 105. A, Lingual view; B, Buccal view.

products. The first discrepancy is in the color and markings of the stock crowns and facings as applied to a given case, faults, however, which are easily remedied. A second

fault is in the shape of these stock teeth and facings. With a knowledge of porcelain building, and a conception of color, the operator may alter these stock products in any manner desired. Porcelain root tips may be approximated, for cleanly and aesthetic contact of bridge dummies with the gum tissues, occlusion may be corrected in gold dentures with cemented crowns or facings, broken teeth may be re-fused, gum blocks may be re-united, and pink porcelain may be added for imitation of natural gum color, where excessive resorption would make the simple porcelain unsightly.

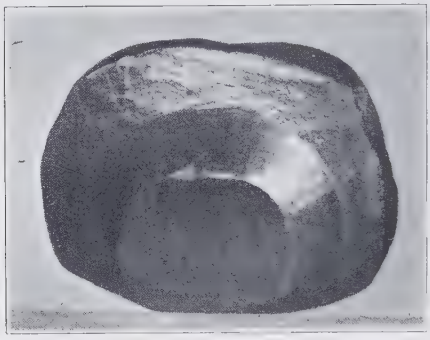
Fig. 107.—Successive steps in porcelain building to Dimlow bicuspids.

Fig. 108.—Remodelling of Dimlow stock teeth—molars and bicuspids, built on with porcelain, sides grooved, and cast gold base cemented. Anterior teeth, built on with porcelain, backed and soldered.

Tooth Staining.—Several types of mineral stains are on the market, those manufactured by Claudius Ash & Sons, The S. S. White Company and by H. D. Justi & Company being perhaps the best-known. A natural tendency on the part of any beginner in this work is to overdo an attempt in imitating anatomical and individual detail. Sharp contrasts in color are seldom found naturally in the mouth. Delicate changes in tooth lines are far more effective, than more startling effects. When imitating stains and imperfections in fissures, a minute quantity of the desired color is mixed

with oil supplied by the manufacturer, or with Frye's Medium, and is applied with a brush in the desired thickness to the area to be stained. This in the case of crown work is

A.



B.

Fig. 109.—Fixed bridges, using porcelain jacket crown construction for tissue side of dummy.

A, Porcelain cemented to place.
B, Formation of tissue side of dummy to receive porcelain base.

usually done before the enamel porcelain is fused. The stain does not change color or intensity during fusing, thereby giving the worker a fair opportunity to gauge the shade desired before fusing.

Remodelling of Long Pin Platinum Facings for Bridge Dummies.—Figs. 103 and 104 show the several steps in the modification of long pin platinum facings. The cemented facing is a great advantage, and the addition of the porcelain root tip not only is an improvement in appearance, but a much more hygienic piece of work in any mouth.

Changing of Stock Porcelain Crowns, and Ash Tube Teeth.—Figs. 105 and 106 show the adaptation of two Ash Tube teeth, which were used as bridge dummies. Palatal and buccal views of the models of this case are sufficient evidence that such modifications not only improve a res-

Fig. 109-C.—Root tip construction.

toration from a hygienic standpoint, but also enhance its appearance.

Modification of Dimlow Stock Teeth.—Fig. 108 illustrates the changing in Dimlow teeth for hygienic bridge dummies. Fig. 109 represents a type of fixed bridge, where virtually a porcelain jacket crown has been made for the lower side of the dummy, and cemented to place.

Porcelain Root Building to Pin Facings.—A 24-gauge metal backing with extending apron (Fig. 109-C) is fitted to facing. This apron is bent to allow for shelf in porcelain. Holding backing in place, the porcelain is added to desired shape, is well dried and condensed. The backing is gently removed and the root tip is fused.

CHAPTER XVI

SUBJECTS WITH WHICH THE STUDENT IN PORCELAIN SHOULD BE FAMILIAR

Tooth Anatomy

The past decade has been the scene of great advances in dental education. Not only have the long established departments of instruction been amplified, but their smaller branches have been studied and taught in a hitherto unknown detail. Of primal importance in porcelain restorations is the revival of interest and instruction in tooth anatomy. The dental graduate of the next five years should know more of the formation of teeth, than any of the older practitioners have ever known or remembered. This naturally demands of the older practitioner new study and application, for in perfect restoration of anatomical detail rests one of the most essential factors of all artificial work in dentistry.

It is not the purpose of this book to present information on tooth anatomy. It is, however, the author's intention to give to the student certain practical suggestions which will be of value in the study of this important subject.

A collection of extracted teeth is of large benefit to the porcelain worker. Crown forms may be classified as to type in relation to the general shape of the corresponding face. Wax models made from good die plates are of great aid in reproducing occlusal detail in posterior teeth. The memory of a book knowledge of tooth anatomy is too poor a guide for practical restorations. Work to reproduce a model.

Anatomical relations of enamel, dentin, and dental pulp are factors too often allowed to slip from the mind. Cross

sections of teeth extracted from patients of as wide a variety of ages as possible will reveal interesting truths, not always remembered. Pulp chambers in the teeth of young and middle-aged persons are usually large, with distinct horn formation in certain teeth, a factor to be watched during the preparation of any vital tooth for porcelain restorations. Pulp chambers in the teeth of persons past middle life present fewer complications as to shape, but furnish an interesting basis for comparison.

Probably the average practitioner will attempt for a time at least to confine his full porcelain restorations to the six anterior teeth, this obviously being their most frequent location. Special effort should be made to master details of anatomy for these teeth: special studies should be undertaken in technic restorations. The reader will remember that while porcelain building may be mastered, it is like most worth while efforts in demanding from its creator thorough preparation and practice.

The Safety of the Dental Pulp Under Vital Tooth Porcelain Restorations

That the operator should exercise a careful regard for conservation of tooth vitality in any restoration is a statement which requires no discussion. That pulps have died under restorations of all characters is quite true. The author has found that the causes of this loss of vitality are easily traced and as easily prevented.

Loss of vitality, applicable to any restoration may be traced to the following causes:

1. Poor judgment in the selection for a vital tooth restoration of a tooth whose vitality, from any of several causes, has already been impaired.

2. Pulp exposure, no matter how minute, either during direct process of preparation, or of long standing under some filling.

3. Pulp injury due to thermal shocks, caused by leaving old fillings in part intact in preparation.

4. Pulp injury due to chemical reactions, applicable to silicate cements of any age, whose presence in proximity of the pulp is extremely dangerous.

5. Careless or ignorant protection of vital preparation, either during preparation, or in the interval between preparation and insertion of finished restoration.

6. Traumatic injury from one cause or another, either from accident or from continued irritation in malocclusion.

Where accident has made doubtful the existence of an otherwise healthy young dental pulp, its future condition should be carefully watched and allowance made for these traumatic injuries in subsequent death under any restoration.

Factors involving pulp injury prior to starting of preparation are obviously beyond the operator's control; unfortunately the resistance of a presumably healthy vital pulp cannot always be diagnosed. Care in selection for restorations, and good judgment in application of the proper form of restoration will reduce mishaps from even this uncertain cause.

Careful protection during preparation is not only possible, but is demanded of any conscientious operator: these steps have been described in detail. The student of porcelain work should consider it as much his duty to safeguard the life of a tooth upon which he works, as it is to reproduce nature as closely as possible.

The Composition of Dental Porcelains

The author is of the opinion that this book is no place for detailed information concerning porcelain composition. The tendency of the age is for results. The close investigator can find complete information on this subject elsewhere.

The three principal components of dental porcelains are silex, kaolin and feldspar, fluxes and pigments being added according to the desired fusing points and desired shade. Kaolin, or silicon of aluminum is composed of aluminum oxide, silicon oxide and water, better known as disintegrated feldspar. Porcelain contains from four to five per cent kaolin. Feldspar is a duplicate silicate of aluminum and potassium, a composition of aluminum oxide, potassium oxide, and silicon oxide. Fluxes consist of such substances as sodium carbonate, sodium borate, potassium carbonate, or glass, which contain oxides of potassium or sodium as principal constituents.

A certain amount of these ground fluxes are mixed with the ground porcelains, and the process of fusing combines them. Colorings in pigments are gold oxide, and tin, obtained from precipitated gold, platinum and purple of Cassius.

Low fusing porcelains are those which may be fused below the melting point of pure gold. Anything above the melting point of pure gold is considered as high fusing. It is a mistaken idea that it always requires an excessive heat to melt porcelain and enamel bodies. Certain porcelains may be fused at temperatures lower than their prescribed fusing point by using a lower heat for a longer period of time. A high fusing porcelain body is safer in manipulation than the lower fusing materials due to the prolonged heat which may be maintained without overfusing and bubble formation.

An Architectural Basis in the Construction of Porcelain Restorations

Operative technic for the various types of tooth restorations in more common use has been so much studied that comparatively firm standards of procedure have been developed. Gold foil technic, amalgam fillings, inlay restora-

Fig. 110.—The joggle or tabled joint.

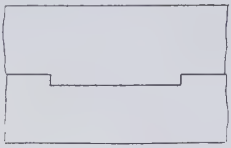


Fig. 111.—The rebated or stepped joint.

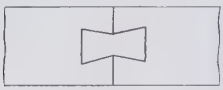


Fig. 112.—The bed joint with dowell.

Fig. 113.—Rebated joint.

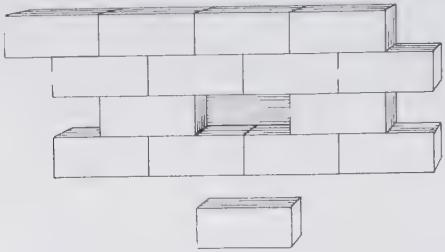
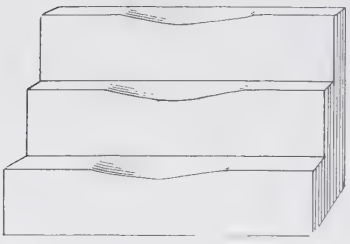
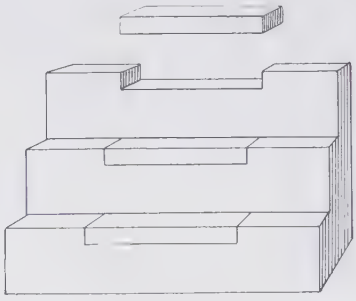


Fig. 114.—The brick walk; the four walled cavity.



A.



B.

Fig. 115.—Mechanical abrasion.
A, Worn steps.
B, Steps repaired: typical three wall cavity.

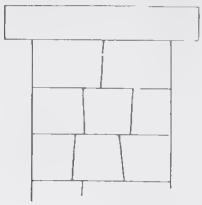


Fig. 116.—The flat coping.

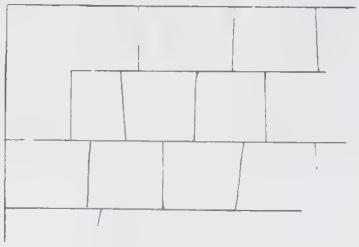


Fig. 117.—The corner coping.

tions, and cement replacements are all based upon fundamental facts and underlying principles for their successful construction. In porcelain work, certain of these fundamentals still hold good, but the practitioner must look beyond the field of routine operative dentistry for a basis for this great work.

Stone masonry was an art before dental porcelain was thought of. A primitive study of the elementary facts in stone masonry will greatly benefit the close student of dental porcelain. Simple illustrations in architectural stone construction will simplify our conception of tooth preparations for porcelain. Nomenclature, value of joints, rests, and anchorages, tension resistance, leverages, and many other basic factors in masonry construction are equally applicable to dental porcelain construction.

Numerous examples of this parallel application are not essential. Certain apt illustrations may be noted, as follows:

1. The tabled joint in masonry to prevent lateral motion in a wall subject to lateral pressure. (Fig. 110.) (The reader will see an obvious application in the construction of the full shoulder coping.) (Fig. 111.)

2. The dowel method of anchorage in masonry is illustrated here. (Fig. 112.) (A true parallel in the construction of post crowns and inlays.)

Flush joints (Fig. 116), flat and corner copings (Figs. 116 and 117), three and four wall cavity preparations in stone masonry construction (Fig. 115) are but slight insights into a wide variety of useful comparisons which the student may find of substantial benefit; it offers an opportunity for study and development.

CHAPTER XVII

THE REPRODUCTION OF STANDARD SHADE GUIDES IN PORCELAIN RESTORATIONS

While the highest attainment in porcelain esthetics is undoubtedly the ability to exercise individual judgment in color building and color blending, it must be admitted that the manufacturers of dental porcelains have done much to aid the student in at least an elementary conception of color reproduction in porcelain. The experienced worker may successfully build his reproduction by matching separate shades from gingival to incisal and combining these several hues into an artistic result. The student who thus conducts his first attempts in this manner would probably invite failure. Therefore, the color approximations outlined for three standard porcelains in the following pages will

TWENTIETH CENTURY	NECK	TIP
6XX	4*–11	12– 6– 1 and a little 15
10XX	4*–11	12– 8–11– 1
14XX	4*–11–8*	11–12– 8
22XX	4*–8	8–15
CONSOLIDATED	NECK	TIP
54 Con.	4*–11	12–13– 1–14
61 Con.	3*–11	12– 6– 2– 1
67 Con.	4*–11	12–11–15
72 Con.	4*–11	10–11–12–14*
S. S. WHITE	NECK	TIP
29 SSW	3*–11	12– 6– 8*–1
31 SSW	4*–11	12– 8–14
38 SSW	4*–11	12–11– 8– 6–15
47 SSW	4*–11	12–15– 9– 4*
JOHNSON & LUND	NECK	TIP
2 J&L	3*–11	12–15– 6
10 J&L	4*–11	12–11–15
30 J&L	4*–11	11–12– 8*
62 J&L	3*–11	12– 1– 6

*Means use a small amount.

prove a valuable aid to any porcelain worker. The student will, however, remember that these proportions are at best only approximations, their relative accuracy depending upon the artistic sense and individual ability of the worker. Their careful study will produce a basis for a greater knowledge and advance in the field of color perception in dental porcelains.

Examples for *S. S. White* Porcelain mixed for the following shades will show surprising results.

Generally speaking all teeth are yellow two-thirds of their length and therefore it is advisable to carry the yellow well down towards the incisal, as in fusing it the different shading will blend harmoniously.

Factors Tending to Defeat Good Color Blending.—

1. Variable in correct fusing to produce the exact shade.

2. Organic basis of natural teeth as compared with inorganic composition of porcelains.

3. Position of porcelain restoration in the mouth. Approximal restorations should be lightened in relative density. Small teeth allow less density of shade than large teeth.

4. Volume of shade exposed on shade guide as compared with the amount necessary for the restoration.

5. Opaque Cements. Very thin restorations; destruction of color by fusing.

A surface on which a beam of light falls may be either rough or smooth. If it be rough, the greater part of the incident light is irregularly scattered by the innumerable surface facets, to be reflected or dispersed in all directions; if it be smooth, a proportion of the incident light is regularly reflected or turned back in definite paths. A smooth dustless mirror is not visible to the eye outside the track of rays reflected from it. If that polished surface be that of a transparent substance, optically denser than the me-

dium conveying the light to it, comparatively little light is reflected. The more oblique the incidence, the smoother the polish, and the greater the difference between the optical density of the glass and that of the medium in which it is immersed, the greater will be the proportion reflected. Less light will be reflected from glass under water than from the same glass in air.

When a beam of light, traveling in a transparent medium impinges obliquely upon the surface of another transparent medium, a part of the light is reflected, and a part of it enters the second medium, but in so doing it is refracted or bent out of its former course.

If a ray of sunlight falls upon a glass prism, it will split up into a color band, which is known as the solar spectrum. These colors upon combining will again produce ordinary white light.

Most substances when exposed to sunlight have the power of reflecting one or more of these colors and of absorbing the rest. Thus, a ray of sunlight, falling upon grass: the grass absorbs all the colors of the white light except green, which it reflects.

In the case of a white flower, none of the colors of the spectrum are absorbed; all are reflected.

A black cloth will absorb all of the colors of the spectrum, reflecting none of them.

Colors vary in hue, purity, and luminosity. The hue determines the name of the color. The luminosity or brightness determines the shade or tone of the color.

The perception of color by the eye is peculiar. Its registration by the eye is in the terms of the complementary color of the one upon which the gaze is fixed.

While the natural teeth in the same mouth will be of the same hue, there will usually be found a marked variation in tint, shade, or saturation. The cuspids have the greatest saturation, and the laterals the least.

Orton believes that the tooth-crown receives its color

mainly from the dentin, although the pulp may be a contributing factor.

About twenty-five per cent of the dentin is made up of organic matter. After the death of the pulp the organic portion of the dentin disintegrates, causing the tooth to become darker, and in some cases, radically changing the hue. In old age, and when the pulp recedes, the hue appears to become more saturated, resulting in some cases in a decided orange.

The color contributed by the enamel is negligible. Normal enamel can be expected to contribute only white, or brightness value to the color of the teeth.

The S. S. White Dental Manufacturing Co. of Philadelphia report as follows:

"We manufacture four different porcelains, 'Medium-Fusing,' 'High-Fusing,' 'Foundation,' and '2560.' Below is a tabulation of the fusing points and the number of shades in each line.

NAME	FUSING POINT	NUMBER OF SHADES OR COLORS
Medium-Fusing	2200F.	25
High-Fusing	2300F.	25
Foundation	2450F.	4
2560	2560F.	15

"Some operators use one grade of porcelain throughout their work. Others use a higher fusing grade for the first bake to form the body or base to build on for shape and color. In succeeding bakes they employ, for the overcolor or enamel, a lower fusing porcelain which, because of its lower fusing point, does not affect the shape of the first bake.

"A number of Jacket-Crown operators make the first bake of our 2560 porcelain, with our High-Fusing porcelain for the second and third. Foundation porcelain (2450) can also be used in the same manner, one of its four colors

being employed for the body, on which an enamel of High or Medium-Fusing porcelain is fused.

"Accompanying this report are tables showing combinations of the various shades of our 2560 and High-Fusing porcelains that will produce the shades of our Tooth Shade Guide. The High-Fusing table applies to the Medium-Fusing porcelain, as the shades are identical. These combinations are, of course, only approximations, but they will serve as a starter. The proportions in which to mix the components of the different combinations to produce any particular variations of the tooth shade desired can only be determined by experiment. It is quite possible, also, that the dentist by experimenting, as he naturally will, when he becomes interested, may evolve better combinations. In seeking these combinations it is not necessary to confine the mixes to two of the shades. Three or more may be brought together, possibly with great satisfaction in securing delicate gradations of shade.

"As an example, if you desire to produce shade No. 28 of our Tooth Shade Guide by a combination of 2560 and High-Fusing or Medium-Fusing porcelains, you would use No. 3 of 2560 for body in the first bake. A mixture of N and R shades of High-Fusing or Medium-Fusing porcelain would then give an enamel for the second bake that would make an excellent reproduction of the tooth shade aimed at. But to get a natural-looking result, the method by which enamel and body are blended in the porcelain tooth must be followed; that is, all body (2560) at the neck, gradually diminishing to near the incisal edge, and the enamel (High- or Medium-Fusing) beginning as a feather edge near the neck and increasing to the full thickness at the incisal edge.

"It must always be remembered that the extremely high fusing point of 2560 porcelain is very apt to cause muffle trouble through expansion and contraction, and that great care must therefore be exercised in its use.

"Because the fusing point of 2560 porcelain approaches

that of porcelain teeth, we do not recommend it for building onto teeth, but suggest a lower fusing grade for that purpose.''

Approximation of S. S. White Tooth Shades in 2560° Porcelain

Tooth Shade	2560° Porc.	Tooth Shade	2560° Porc.
26–	13 enamel 11 body	39–	6 enamel 3 & 4 body
27–	1 enamel 3 body	40–	15 enamel 3 body
28–	14 & 1 enamel 3 body	41–	15 & 3 enamel 3 body
29–	14 & 1 enamel 11 body	42–	3 & 1 enamel 4 body
30–	14 enamel 3 body	43–	3 enamel 4 body
31–	14 & 8 enamel 3 body	44–	14 & 10 enamel 3 body
32–	14 & 8 enamel 4 body	45–	10 enamel 3 body
33–	14 & 8 enamel 4 & 9 body	46–	10 & 14 enamel 3 & 4 body
34–	2 enamel 11 body	47–	8 enamel 3 & 4 body
35–	2 enamel 3 body	48–	8 & 9 enamel 4 & 9 body
36–	13 & 3 enamel 3 body	49–	9 enamel 4 body
37–	12 & 14 enamel 3 body	50–	9 enamel 4 body
38–	12 & 14 enamel 3 body		

''This means that all shades on the tooth shade guide are made by the blending of two colors—a body and an enamel. In the duplication of these shades in material of the High-Fusing Porcelain much depends on the blending of the two letters suggested in each of the above cases. It must be understood that the letters here suggested only approximately duplicate the tooth shades, and it is quite possible for the student perhaps to select other combinations which

Duplications of S. S. White Tooth Shades in S. S. White High-Fusing Porcelain

Tooth Shade	A to Z porcelain
26	G and N
27	G " P
28	N " R
29	N " T
30	C " I
31	C " R
32	C " H
33	D " H
34	G " T
35	G " I
36	T " R
37	T " I
38	T " H
39	T " J
40	M " I
41	N " I
42	N " H
43	R " H
44	Z " R
45	Z " I
46	Z " K
47	M " H
48	K " L
49	M – L – H
50	J and H

Justi High-Fusing Porcelain

Fac-simile of Original System of Formulas

Use No.	1 as Enamel with No.	3 as Body to Make Shade	1 Justi Shade Guide
" "	2 " " " "	3 " " " " "	2 " " "
" "	3 " " " "	6 " " " " "	3 " " "
" "	4 " " " "	4 " " " " "	4 " " "
" "	5 " " " "	5 " " " " "	5 " " "
" "	6 " " " "	5 " " " " "	6 " " "
" "	7 " " " "	6 " " " " "	7 " " "
" "	8 " " " "	4 " " " " "	8 " " "
" "	9 " " " "	4 " " " " "	9 " " "
" "	10 " " " "	4 " " " " "	10 " " "
" "	11 " " " "	5 " " " " "	11 " " "
" "	12 " " " "	21 " " " " "	12 " " "
" "	13 " " " "	4 " " " " "	13 " " "
" "	14 " " " "	5 " " " " "	14 " " "
" "	15 " " " "	5 " " " " "	15 " " "
" "	16 " " " "	5 " " " " "	16 " " "
" "	17 " " " "	21 " " " " "	17 " " "
" "	18 " " " "	21 " " " " "	18 " " "
" "	19 " " " "	4 " " " " "	19 " " "
" "	20 " " " "	5 " " " " "	20 " " "
" "	21 " " " "	21 " " " " "	21 " " "
" "	22 " " " "	23 " " " " "	22 " " "
" "	23 " " " "	23 " " " " "	23 " " "
" "	24 " " " "	23 " " " " "	24 " " "

may give him a closer match. These are given merely as a starter and if the student is willing to accept them as such they may possibly be of some assistance to him."

Whiteley's Twentieth Century Porcelain Inlay Material

(The Dentists' Supply Co., New York)

"This outfit contains ten jars of material of different colors from a combination of which any tooth shade can be closely approximated. We give below formulas for making the shades on the Twentieth Century Tooth Shade Guide.

"This material fuses at about 1900 Degrees F. and care should be exercised to prevent overheating it.

"The complete set contains ten (10) jars of material, as follows:

A—White.
B—Colorless (Plain Inlay).
C—Blue.
D—Blackish Brown.
E—Yellow (Deep).
F—Gum.
G—Pinkish Yellow.
H—Light Yellow.
J—Black.
XX—Colorless (Foundation Body).

"A, B, C, D, E, F, G, H are to be used, as per formulas to match the Twentieth Century Shades.

"The J material is used to make darker shades than those of the Twentieth Century Shades given in the formulas.

"The XX material is a colorless foundation body, higher fusing than the other materials in the set and specially treated so that it will not shrink when fused. It is used to mix with the colored materials to form a base when two or more bakings are required. By varying the proportions of

this XX material the fusing point of the different layers can be varied.

"Shade F, which is a gum color, will be found very useful for gum enamel work.

"The following formulas are the result of many careful experiments. If carefully followed any shade of the Twentieth Century Shade Guide can be obtained. It is difficult to state the exact time and heat to be used as so many varying elements are present, but practice will enable the operator to determine the proper heat to get the best results. Too high a heat will cause the porcelain to become glossy and to lose a certain amount of color."

Formulas for Making the 25 Twentieth Century Tooth Shades from Basal Colors of Inlay Material

The formulas are in two parts, one part referring to the shade of the body, or neck, and the other part to the enamel, or cutting edge, of the Twentieth Century Shade Guide Teeth.

Twentieth Century Tooth Shades.	To Produce the Shade of the Body or Neck.	To Produce the Shade of the Enamel or Cutting Edge.
Shade 1	1 parts B 2 " H	1 parts A 5 " B 1 " H
Shade 2	1 parts B 4 " H	4 parts B 1 " C 2 " G 1 " H
Shade 3	2 parts G 5 " H	3 parts B 1 " C 1 " H
Shade 4	1 parts B 2 " H	1 parts A 4 " C 3 " H
Shade 5	1 parts B 5 " H	1 parts A 2 " B 2 " C 3 " H

Twentieth Century Tooth Shades.	To Produce the Shade of the Body or Neck.	To Produce the Shade of the Enamel or Cutting Edge.
Shade 6	1 parts G 6 " H	4 parts B 1 " C 1 " G 3 " H
Shade 7	5 parts B 3 " E 2 " G	4 parts B 3 " H
Shade 8	1 parts G 6 " H	3 parts B 1 " C 4 " H
Shade 9	1 parts G 4 " H	2 parts B 1 " C 2 " G 3 " H
Shade 10	1 parts G 8 " H	1 parts A 2 " B 2 " C 4 " H
Shade 11	3 parts G 5 " H	1 parts B 2 " C 2 " G 4 " H
Shade 12	2 parts G 5 " H	3 parts B 3 " C 1 " D 4 " H
Shade 13	2 parts G 5 " H	2 parts C 2 " B 1 " D 3 " H
Shade 14	1 parts G 4 " H	2 parts B 1 " C 1 " D 2 " H
Shade 15	1 parts B 2 " E 3 " G	1 parts B 2 " G 1 " H
Shade 16	1 parts G 4 " H	1 parts B 2 " G 5 " H
Shade 17	1 parts G 4 " H	1 parts C 3 " H
Shade 18	1 parts E 3 " G	1 parts C 1 " D 2 " H

Twentieth Century Tooth Shades	To Produce the Shade of the Body or Neck.	To Produce the Shade of the Enamel or Cutting Edge.
Shade 19	1 parts D 2 " E 6 " G	1 parts C 1 " D 4 " H
Shade 20	3 parts E 5 " G	1 parts G 2 " H
Shade 21	2 parts E 3 " G	1 parts G 6 " H
Shade 22	1 parts D 2 " E 3 " G	1 parts C 2 " D 2 " H
Shade 23	2 parts D 4 " E 3 " F	1 parts C 2 " D 3 " H
Shade 24	5 parts E 3 " F 2 " H	1 parts A 2 " D 2 " E
Shade 25	1 parts D 4 " E 2 " F	2 parts A 3 " D 3 " E

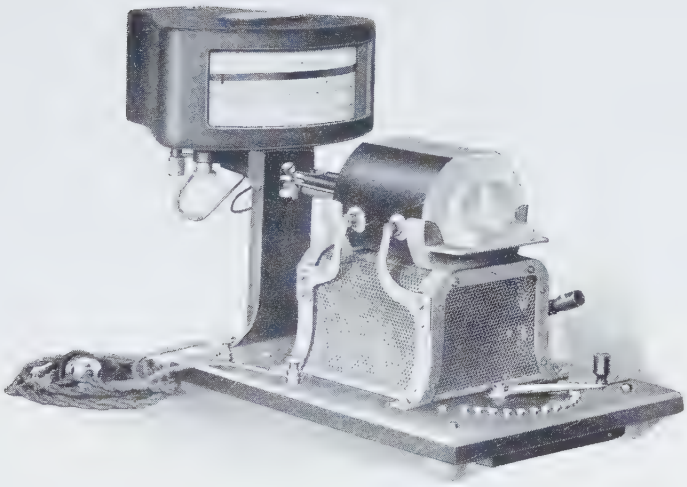
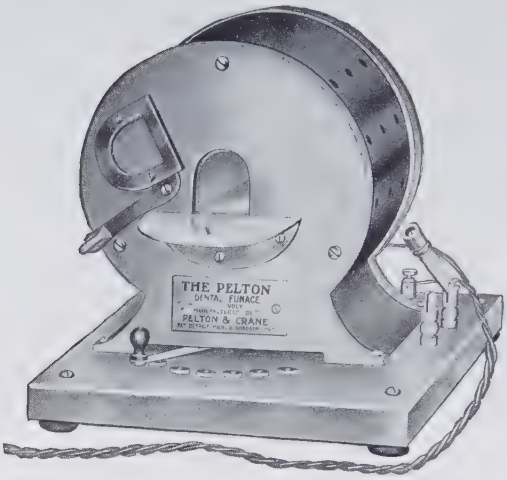
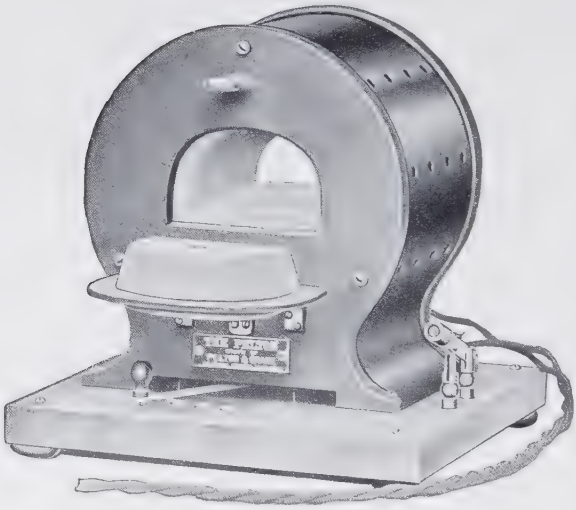


Fig. 118.—The S. S. White porcelain furnace with pyrometer.



1.



2.

Fig. 119-A.—The Pelton porcelain equipment. No. 1, Dental Furnace. Inlay, crown and bridge size; No. 2, Dental Furnace. Continuous gum size.

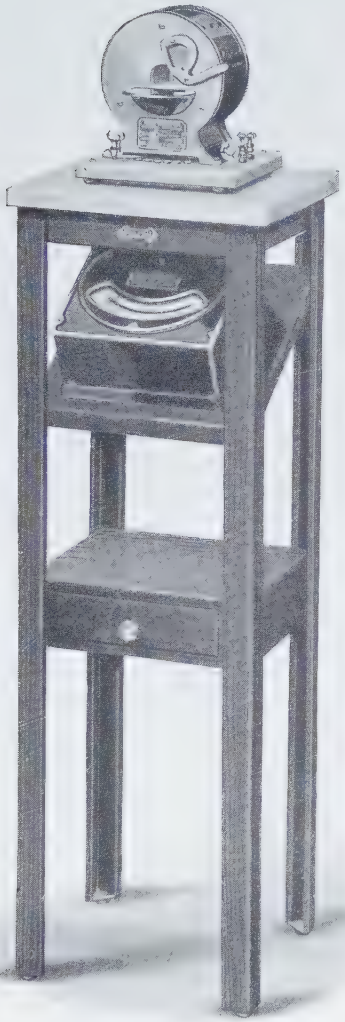


Fig. 119-B.—The Pelton porcelain equipment, showing dental furnace with pyrometer and table complete.

Fig. 120.—Roach automatic pyrometer furnace.

Fig. 121.—The Bridge furnace.

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